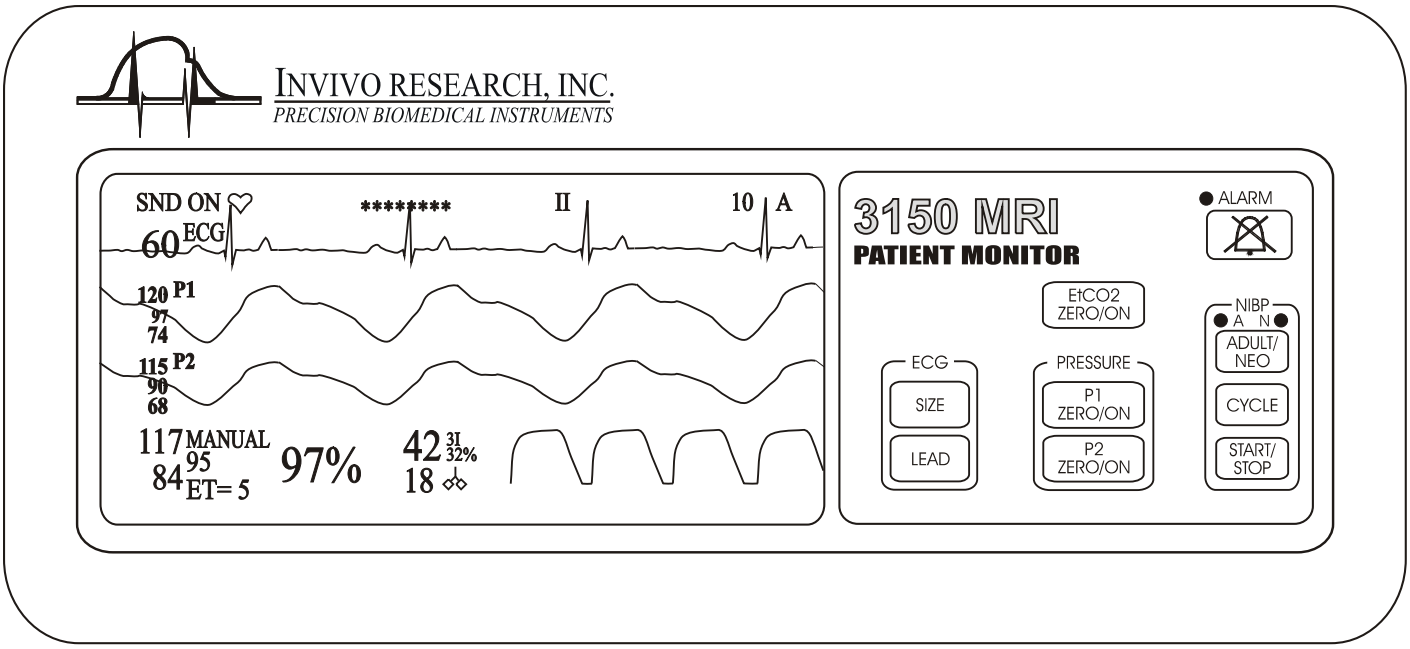
9539

# Magnitude™ 3150M MRI Monitor
# Omni-Trak™ 3150 MRI Monitor




# Service Manual

## Volume I
## Maintenance Instructions

INVIVO
RESEARCH, INC.

# Invivo Research, Incorporated

## Magnitude™ 3150M MRI Monitor
## Omni-Trak™ 3150 MRI Monitor

# Service Manual

**INVIVO**
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# GENERAL SERVICE PRECAUTIONS

**Obtain a thorough understanding of each of the following precautions before attempting to perform any disassembly or service procedure. Damage to the instrument or injury to yourself may result if these precautions, as well as common sense, are not used.**

Service to this product should only be performed by trained, qualified service personnel familiar with the operation and service documentation for this monitor.

Shock Hazard exists when this monitor is operated without the chassis cover. Use caution when working on units with power applied.

Always disconnect monitor from AC Main Power before performing service on internal assemblies.

Due to the monitor's internal battery, power may be present even when disconnected from the AC Main Power. When necessary, disconnect the internal battery prior to performing service or shipping the system to the manufacturer for repair.

Replace fuses with same type and rating only.

Always follow proper electrostatic discharge (ESD) procedures during component and assembly handling to prevent static discharge damage to sensitive parts.

Use only replacement parts specified in this manual.

When cleaning the unit, do not permit liquid to enter the case. When cleaning, use proper materials and ensure total dryness before powering the monitor. Use care that cleaning fluids do not attack plastic or painted surfaces. Use care that wiping rags do not abrade the surfaces.

Assembly hardware has been secured with a thread locking agent. After several assembly/disassembly cycles new locking agent will be required. (Use Loctite 42540 or similar type for use near PVC or acrylic plastics.)

In general, handle all Printed Circuit Boards by their edges. Oils, sweat, dirt, etc. can induce leakage paths in high impedance circuits which impede their operation. Such contamination will also promote corrosion of circuits yielding a long term reliability problem.

Avoid rough handling of all exposed chassis parts and front panel overlay. These parts can be scratched causing obtrusive cosmetic defects.

This system is intended for use in the Magnetic Resonance Imaging (MRI) areas. Use only non-ferrous or non-magnetic replacement parts in the monitor.

# MRI SERVICE PRECAUTIONS

**NOTE**

In addition to these precautions, cautions and warnings are located in paragraphs 4.0 (Page 4-1) and 4.8 (Page 4-9).

## CAUTION

Federal law in the USA and Canada restricts this device to sale by, or on the order of, a licensed medical practitioner.

This monitor is not intended for use in the presence of **FLAMMABLE ANESTHETICS**. **An explosion hazard exists.**

Never immerse the monitor in any fluid or attempt to clean it with liquid cleaning agents. **An electrical hazard exists.**

Do not remove the monitor's cover. **A shock hazard exists**. Refer servicing to qualified personnel only. No repair should be undertaken or attempted by anyone not having a thorough understanding of the repair and safety assurance of patient monitors.

**Risk of RF current burn.** Cables which become inadvertently looped during MRI act as conductive lines for RF induced currents. When lead wires or other cables form conductive loop in contact with the patient's tissue, minor to severe burning can result.

**Perform the following to minimize risk of RF current burn:**

1. Place cables and lead wires neatly in straight alignment with no looping.
2. Keep the length of lead wires and patient cable within the bore to a minimum.
3. RF burn risk increases when multiple sensors/cables are in use. Such combinations are not recommended.
4. The high radio frequency (RF) power used in MR scanning poses an ever-present risk of excessive heat at the monitoring sites and, therefore, the risk of RF current burn. **Should power levels greater than S.A.R. of 4 w/kg peak (0.4 w/kg average) be used, the risk of patient burn greatly increases.** As a result, monitoring of ECG or Respiration (derived from ECG leads) at power levels of greater than 4 w/kg peak (0.4 w/kg average) is not recommended for the general patient population. Such monitoring should only be attempted on conscious patients with good temperature reflex so they may warn the operator of excessive heat at the monitoring sites.
5. **High RF Power may cause patient heating or burns. For scans with average S.A.R. > 1 w/kg, limit scan time to 5 minutes and pause at least 3 minutes between scans to allow ECG Cable to cool.**

**NOTE**

Use only Invivo Research Fiber Optic Sensors and other MRI Compatible accessories with this monitor.

MRI Compatibility

The Quadtrode™ MRI ECG Electrode Pad, and ECG Patient Lead Wires and Cable, are compatible with Magnetic Resonance Imaging (MRI) Systems within the following guidelines:

- MRI Systems with static magnetic field strengths up to 1.5 Tesla.
- Usable within the MRI system bore with Specific Absorption Ratios (S.A.R.'s) up to 4.0 w/kg (peak). Use with higher S.A.R.'s greatly increases the risk of patient burns.
- Non-magnetic materials are used in the construction of these assemblies.
- If scanned directly across the plane of the ECG electrode element, a slight image distortion may be seen at the skin surface where the electrode element is positioned.

# USER RESPONSIBILITY

This product will perform in conformity with the description contained in the Operations Manual for the **Omni-Trak™ 3150/MAGNITUDE™ 3150M MRI Monitor** (IRI Part Number 9538) and accompanying labels and/or inserts, when assembled, operated, maintained, and repaired in accordance with the instructions provided. This product must be checked and calibrated periodically. Recommended calibrations should be performed every six months. Operational checks should be done with each use.

A defective product should not be used. Parts that are broken, missing, plainly worn, distorted, or contaminated should be replaced immediately. Should such repair or replacement become necessary, Invivo Research, Incorporated (IRI) recommends that a telephone call or written request for service be made to the nearest factory service center. This product or any of its parts should not be repaired other than in accordance with written instructions provided by IRI or altered without the prior written approval of IRI. The user of the product shall have the sole responsibility for any malfunction which results from improper use, faulty maintenance, improper repair, damage, or alteration by anyone other than IRI authorized service personnel.

There are no user maintenance requirements. All maintenance requirements are to be done by qualified Service Personnel only.

# SECTION I

# THEORY OF OPERATION

## 1.0 THEORY OF OPERATION

**1.1 ECG ISO Board AB86.** A 40 KHZ reference signal, supplied by the ECG Analog board, is fed through T1 then rectified and filtered in the ISO power metal box for the + and - 12V ISO supplies.

ECG lead surge protection is provided by surge arresters LP 1-5. Additional protection and signal conditioning is provided by U2, U3 and associated circuitry.

Lead selection is provided by U14,U15,U16, U4,U5,U7 and U8. RL drive is selected by U1 and associated circuitry.

U9 and associated circuitry provide amplification and filtering for stabilization of the channel 1 signal before passing through ISO Barrier U12. U23 and associated circuitry provide the proper DC offset before the signal is sent to the ECG Analog Board.

U10 and associated circuitry provide amplification and filtering for stabilization of the channel 2 (CAL) signal before passing through ISO Barrier U24. U23 and associated circuitry provide the proper DC offset before the signal is sent to the ECG Analog Board.

**1.2 ECG Analog Non-ISO Board AB87.** Channel 1 ECG signal is again filtered and amplified to 1V per 1mv by U20, U32, U42 and associated circuitry. Channel 2 ECG signal is again filtered and amplified to 1V per 1mv by U20, U26, U22 and associated circuitry. Both channels are fed into U1 then sent to the AB47 Signal Processor board.

A 40 KHZ crystal is amplified and used for ISO power reference (T1.5). It is also used as a clock where after divided by U8 and U3 a 1.22 HZ CAL signal is generated. Lead selection and RL drive are driven by U2.

**1.3 Invasive Pressure ISO Board AB89.** A 40 KHZ reference signal, supplied by the Invasive Pressure Non- ISO board, is fed through T1 then rectified and filtered in the ISO power metal box for the + and - 12 Vdc ISO supplies. U7 and associated circuitry provide regulation for the 1.53 Vdc transducer excitation reference voltage.

U1, U2, U5 and associated circuitry provide amplification and signal conditioning before passing through ISO Barrier U6 and U10. The output gain and DC zero offset are controlled by U3 and associated circuitry.

Later versions of this board include a slew rate filter circuit. The slew filter extracts pressure signals in the presence of large MR gradient pulses. This function is provided by U4, U12, U13 and U14. DC shift caused by this interference is neutralized by R69 (Channel 1) and R45 (Channel 2).

**1.4 Invasive Pressure Non-ISO Board AB90.** P1 and P2 signals are received from the Invasive pressure ISO board AB89, and filtered by U4, U5 and associated circuitry.

U7 - U10 provide 8 bit D-A conversion along with U11, I/O parallel programmable CMOS.

A 40 KHZ crystal is amplified and used for ISO power reference (T1.5).

**1.5 Interconnect Board AB75.** The AB75 provides interconnections for the LCD Module Display, backlight, Alarm speaker, ON/OFF switch and keypad. It also houses the Adult, Neo, Alarm drivers and LEDs.

**1.6 Pneumatics Box AP45A.** The AP45A Pneumatics Box houses the NIBP pump, Humphrey valve, NIBP overpressure valve, EtCO2 pump and pneumatic valves. It also houses the LCD display backlight inverter which converts 5 Vdc to approximately 900 VAC for the LCD backlight supply voltage.

**1.7 Power Supply Board (AB76 Configuration).** In the AB76 configuration, power is supplied to this monitor's operational circuits by the AB76 Power supply board.

The +5 Vdc supply is regulated by a DC to DC converter U6 and its related circuitry.

The +12 Vdc supply is regulated by U5. When in battery operation Q4 turns on switching regulator U7 to boost the voltage maintaining sufficient U5 input regulator voltage.

The -12 Vdc supply is regulated by DC to DC converter U4 and its related circuitry.

The +10 Vdc supply is regulated by U3 using the +12 Vdc supply as reference.

1.7.1 Battery Charger. The battery charger is comprised of VR1, U1, Q3, Q6, Q7, Q8 and associated components. Components VR1, R39, R7, D29, D35, D30 and C41 form an adjustable voltage reference which is adjusted by R6 to the maximum battery charge voltage. The diodes, D29, D35 and D30 are located in the reference leg of VR3 to provide temperature compensation for the battery. C41 provides output voltage stability for the adjustable voltage reference output. U1 and associated components C43, C44, D27, D28, R29, R35, R36, R42, R44 and R47 form a two stage voltage comparator which is used to monitor battery voltage and control the charger switching circuit.

Resistors R29 and R47 form a voltage divider with a nominal voltage of 8.1 Vdc (which represents an undervoltage battery condition) and is applied to U1-3. Resistor R36 applies the battery voltage to the other side of the undervoltage comparator at U1-2. Resistor R45 connects the output of the undervoltage comparator U1-1 back to the positive input of the undervoltage comparator where it is used to provide approximately 80mV of hysteresis about the comparator threshold. This results in circuit stability when the battery undervoltage crossover point is present. The output of the battery undervoltage comparator is low (less than 1.5 Vdc) under normal battery conditions and does not affect the operation of the second (over-voltage) comparator.

When an undervoltage battery condition is detected the comparator output will be high and will be applied through D27 to U1-6 where it will override the high impedance battery input and result in the battery charger being turned off. The present battery voltage is also applied through R35 to U1-6 as a high impedance input. C44 filters this voltage for stability during comparator crossover conditions.

The adjustable battery reference voltage is applied to the other side of the high battery voltage comparator at U1-5 through R44. The output of the high battery voltage comparator occurs at U1-7 and is applied to the battery charger switching circuit. Resistor R42 provides approximately 30mVdc of negative hysteresis for stability as the battery approaches a fully charged condition.

The output of the high battery voltage comparator at U1-7 will be high when the battery terminal voltage is between 5.2 and the battery reference voltage as set at the output of VR3 (normally 14.84 Vdc). Capacitor C43 is a filter at the positive power terminal of U1. Diode D28 clamps the input

at U3-6 to a value no greater than $V_{cc}$ +0.7 Vdc to provide a low impedance discharge path for C44 during input power down condition.

When the output of the battery comparators is high, the battery charger switching circuit will be turned on. A voltage of less than 17.0 Vdc will be present at the emitter of transistor Q6 and not enough current can flow through resistors R4, R33 and across diode D25 to cause transistor Q6 to saturate.

The voltage at the base of transistor Q7 will cause Q7 to conduct current through resistors R21, R34, R8 and across diode D2 into the battery. This will turn on transistor Q8 and apply a forward bias to the base of transistor Q3, turning Q3 on. Capacitor C46 will delay slightly the turn on (and turn off) time of transistor Q8. When transistor Q3 is turned on, current will flow into L1, C36, across resistor R9 and through diode D2 into the battery.

When approximately 1.0 ampere of current is flowing through resistor R9, a voltage large enough to turn on transistor Q5 will be developed (0.65 Vdc). Resistor R20 limits the base current of Q5. When Q5 is saturated the voltage across the emitter-base junction of transistor Q7 will fall below the level required for conduction and Q7 will turn off. Transistors Q8 and Q3 will be turned off. Current will continue to flow into the battery through diode D20, L1, R9 and D2 due to the field collapse of coil L1. Capacitor C36 will also provide a current source at this time. When current flowing out of coil L1 and capacitor C36 is no longer sufficient to maintain a voltage saturating the emitter-base junction of transistor Q5, transistor Q7 will turn on and the cycle will repeat. The cycle frequency is determined by the LC time constant of L1 and C36 and is approximately 8.4 KHz.

When the battery is sufficiently charged, the voltage to the battery comparators becomes positive enough to allow the output to switch low at U1-7. Enough current then flows through R4, R33 and diode D25 to turn on transistor Q6 and transistor Q7 is held in the cutoff condition until further charging is required.

**1.8 Power Supply Board (AB152 Configuration).** In the AB152 configuration, power is supplied to this monitor's operational circuits by the AB152 Power supply board.

The +5 Vdc supply is regulated by a DC to DC converter U6 and its related circuitry.

The +12 Vdc supply is regulated by U5. When in battery operation Q4 turns on switching regulator U7 to boost the voltage maintaining sufficient U5 input regulator voltage.

The -12 Vdc supply is regulated by DC to DC converter U4 and its related circuitry.

The +10 Vdc supply is regulated by U3 using the +12 Vdc supply as reference.

1.8.1 Battery Charger. The battery charger is comprised of VR1, U1, Q3, Q6, Q7, Q8 and associated components. Components VR1, R39, R7, D29, D35, D30 and C41 form an adjustable voltage reference which is adjusted by R6 to the maximum battery charge voltage. The diodes, D29, D35 and D30 are located in the reference leg of VR3 to provide temperature compensation for the battery. C1 provides output voltage stability for the adjustable voltage reference output. U1 and associated components C43, C44, D27, D28, R29, R35, R36, R42, R44 and R47 form a two stage voltage comparator which is used to monitor battery voltage and control the charger switching circuit.

Resistors R29 and R47 form a voltage divider with a nominal voltage of 7.9 Vdc (which represents an undervoltage battery condition) and is applied to U1-3. Resistor R36 applies the battery voltage to the other side of the undervoltage comparator at U1-2. Resistor R45 connects the output of the undervoltage comparator U1-1 back to the positive input of the undervoltage comparator where it

is used to provide approximately 80mV of hysteresis about the comparator threshold. This results in circuit stability when the battery undervoltage crossover point is present. The output of the battery undervoltage comparator is low (less than 1.5 Vdc) under normal battery conditions and does not affect the operation of the second (over-voltage) comparator.

When an undervoltage battery condition is detected the comparator output will be high and will be applied through D27 to U1-6 where it will override the high impedance battery input and result in the battery charger being turned off. The present battery voltage is also applied through R35 to U1-6 as a high impedance input. C44 filters this voltage for stability during comparator crossover conditions.

The adjustable battery reference voltage is applied to the other side of the high battery voltage comparator at U1-5 through R44. The output of the high battery voltage comparator occurs at U1-7 and is applied to the battery charger switching circuit. Resistor R42 provides approximately 2.2 Vdc of negative hysteresis for stability as the battery approaches a fully charged condition.

The output of the high battery voltage comparator at U1-7 will be high when the battery terminal voltage is between 5.2 and the battery reference voltage as set at the output of VR3 (normally 14.5 Vdc). Capacitor C43 is a filter at the positive power terminal of U1. Diode D28 clamps the input at U1-6 to a value no greater than $V_{cc}$ +0.7 Vdc to provide a low impedance discharge path for C44 during input power down condition.

When the output of the battery comparator is high, the battery charger switching circuit will be turned on. A voltage of less than 17.0 Vdc will be present at the emitter of transistor Q6 and not enough current can flow through resistors R4, R32 and across diode D25 to cause transistor Q6 to saturate.

The voltage at the base of transistor Q7 will cause Q7 to conduct current through resistors R21, R34 and R8 into the battery. This will turn on transistor Q8 and apply a forward bias to the base of transistor Q3, turning Q3 on. Capacitor C46 will delay slightly the turn on (and turn off) time of transistor Q8. When transistor Q3 is turned on, current will flow into L1, C36, across resistor R9 and through diodes D14, D15, D16 and D17 into the four batteries.

When approximately 1.0 ampere of current is flowing through resistor R9, a voltage large enough to turn on transistor Q5 will be developed (0.65 Vdc). Resistor R20 limits the base current of Q5. When Q5 is saturated the voltage across the emitter-base junction of transistor Q7 will fall below the level required for conduction and Q7 will turn off. Transistors Q8 and Q3 will be turned off. Current will continue to flow into the battery through diode D20, L1, R9 and D2 due to the field collapse of coil L1. Capacitor C36 will also provide a current source at this time. When current flowing out of coil L1 and capacitor C36 is no longer sufficient to maintain a voltage saturating the emitter-base junction of transistor Q5, transistor Q7 will turn on and the cycle will repeat. The cycle frequency is determined by the LC time constant of L1 and C36 and is approximately 8.4 KHz.

When the battery is sufficiently charged, the voltage to the battery comparators becomes positive enough to allow the output to switch low at U1-7. Enough current then flows through R4, R33 and diode D25 to turn on transistor Q6 and transistor Q7 is held in the cutoff condition until further charging is required.

Each of the four batteries has its own diode for charge and discharge. This helps prevent a battery with a dead cell from discharging the other batteries.

A battery protection circuit consisting of U2 and associated components, and Q12 is used to prevent deep discharge of the batteries. If the battery output voltage, DC_PRESENT, drops below +10 Vdc, U2-1 will go high turning off Q12. In this state, the load on the batteries is reduced to less than 1mA

to avoid a deep discharge condition. Then, if external power of +15 Vdc or greater is applied, U2-1 will go low enabling Q12 to pass main power.

**1.9 MRI Gating/Analog AB116 (Option).** Printed circuit board assembly part number AB116 provides both analog signals as well as TTL pulses to the MRI gating output connector on the base of the Model 3150/3150M. See Volume II - AC356 for pin description.

The circuit composed of U5 (Digital-to-Analog Converter), U6, and U8 provide analog signal outputs. These analog signals include both low and high amplitude ECG signals, high level invasive pressure (P1) signal, high level respiration (from ETCO2) signal, and low and high amplitude pulse signals. The low and high amplitude pulse signals are selected by the position of JMP1. When the jumper is set between pins 1 and 2 the high level signal is output and, likewise, when set between pins 2 and 3 the low level signal is output. U7A and its related components provide the reference voltage to U5 (DAC).

The network of U1, U2, and U3 provides TTL outputs corresponding to the peaks of the heart rate (HR) source signal, invasive pressure 1 (P1), respiration(from ETCO2), and pulse signal. The HR source signal is software selectable through the HR source selection in the ECG menu of the Model 3155MVS/3155A. The TTL pulses have an amplitude between 3.3 and 5.0 $V_{pp}$ and a duration of 13 ±3 ms.

**1.10 Oximeter Board AB22.** The AB22 Board contains the Oximeter Processor Circuitry. This board contains the hardware necessary to control the Oximeter System Operation, it performs the Timing and Measurement Operations using Counter Timers (82C53) under the control of the microprocessor, provides for Data Memory Storage (with data provided by a 32K by 8 bit ROM and an 8K by 8 bit static RAM) and interfaces with the Signal Processor and Master Processor Ports.

1.10.1 Isolation Section. The Oximeter Analog Section provides patient input parameter measurement and patient isolation. The isolated section consists of four functional circuit elements: timing and control, LED drive, the receiver/amplifier and ramp comparator circuits.

a. The timing and control circuits perform system timing functions that maintain synchronic action between the LED drive, signal comparator and demodulator circuits.

b. The LED drive section contains two drive level integrators, a drive signal multiplexer and a differential drive amplifier to control the intensity of the red and IR LED's contained in the particular SpO2 sensor.

c. The receiver/amplifier consists of a two stage, high gain, bandpass receiver amplifier followed by a pair of demodulators and three pole low pass filters for signal recovery and processing.

d. The ramp and comparator circuits consist of a precision 10.00 Vdc reference, a precision ramp generator, analog sampling switches and three comparators used to detect voltage crossover levels for timing comparisons.

**1.11 Mother Board AB67M.** The Mother Board contains the connectors which interface the major assemblies of the monitor together. In addition, this board also houses the Non-Invasive Blood Pressure (NIBP) pump circuitry, NIBP Clock, front overlay interface circuitry, low battery shutoff reference divider and communications driver.

1.11.1 Non-Invasive Blood Pressure (NIBP) Pump Circuitry. Q1 drives the NIBP Pump with the drive signal provided by the NIBP board (AB06DJ). The pump signal varies according to whether the monitor is set in the Adult or Neonatal NIBP mode. In the Adult mode the pump drive signal

is a DC voltage whereas in the Neonatal mode the signal is pulse width modulated. Q2 provides a current limit for the pump drive.

1.11.2 NIBP Clock. X1 supplied the 4 MHz for the AB06DJ and U6 divides it by 2 to supply the 2MHz Clock.

1.11.3 Front Overlay Interface Circuitry. The combination of pull up resistors (R7, R8, R9 and R10A through F), diodes (D9, D10, D11, Z1, Z2 and Z3), and front overlay make up the matrix that interface the membrane switches to the master processor.

**1.12 Signal Processor Board AB47.** The Signal Processor receives analog signals from the ECG, ETCO2, Invasive Pressure and SpO2 boards via the Input/Output ports and converts the analog signals to a digital format for analysis at the Master Processor and display. The Signal Processor also sends commands to the parameter boards through these Input/Output ports.

**1.13 Master Processor AB119.** The Master Processor board contains the microprocessor, supporting Random Access Memory (RAM), Read Only Memory (ROM), Input/ Output circuitry, and audio tone and alarm circuitry.

1.13.1 Microprocessor. The Master Processor utilities a 64180 microprocessor at location U7 and related circuitry for the processing of patient data for analysis and display.

1.13.2 Random Access Memory (RAM). U15, U18, and U19 contain Random Access Memory (RAM) for use by the microprocessor when executing instructions.

1.13.3 Read Only Memory (ROM). U18 and U19 contain Erasable/Programmable ROM (EPROM) which contain the operating instructions to be used by the processor for monitor operations.

1.13.4 Input/Output Circuitry. Input/ Output circuitry at locations U20 through U22 interface the Master Processor to the parameter boards, Signal Processor, and other peripheral devices.

1.13.5 Audible Tones and Alarms. The combination of U8, U16, and U 32 provide the audible tones and alarms.

**1.14 Non-Invasive Blood Pressure (NIBP) Board AB06DJ.** The NIBP board contains the circuitry for obtaining Adult and Neonatal non-invasive blood pressure. The board receives an input signal from the pressure transducer which contains the oscillometric signal. This signal is amplified and filtered and used to determine the NIBP readings. In addition the board provides outputs to control the NIBP pump and valve assemblies.

1.14.1 Microprocessor. The NIBP board utilizes a Z80 4MHZ processor (location U14) that communicates directly to the Master Processor through the Input/Output ports at locations U10 and U12.

1.14.2 Analog to Digital Converter. U9 is a six channel A to D converter with inputs from the over-pressure switch, fail-safe timer, +5.12 reference voltage, Adult oscillometric signal, Neonatal oscillometric signal, and pressure signal.

1.14.3 Programmable EPROM. U12 contains the operating instruction and algorithm for NIBP operation.

1.14.4 Pump and Valve Control. The pump and valve drive signals are developed at the microprocessor and output through Input/Output ports at location U12.

1.14.5 Transducer. The transducer is pneumatically attached to the to the sense port at the monitors column assembly. The pneumatic pressure along with the oscillometric signal is converted to analog signals and routed directly to the NIBP board where it is amplified and filtered for analysis.

1.14.6 Adult Mode. When the front panel indicator shows Adult the pump will run at a higher speed and the gain and filtering of the oscillometric signal amplifiers are set accordingly. The processor uses the digitized Adult oscillometric signal from the A to D converter for making blood pressure determinations.

1.14.7 Neonatal Mode. When the front panel indicator shows Neonatal the pump drive signal is pulse width modulated and the gain and filtering of the oscillometric signal amplifiers are set accordingly. The processor uses the digitized Neonatal oscillometric signal from the A to D converter for making the blood pressure determination.

1.14.8 Over-Pressure Switch. The over-pressure switch is located on the side of the Pneumatics Box (AP45). It is a mechanical switch that is set to interrupt the NIBP function when pressure in the pneumatic section exceed 270 mmHg.

**1.15 End Tidal CO2 (ETCO2) Option.** The End Tidal CO2 (ETCO2) option is divided among two assemblies. The ETCO2 electronics is contained on the circuit board assembly part number AB115. The ETCO2 pneumatic hardware (pump, valve 1, valve 2, and valve 3) are contained in the pneumatic box part number AP45A.

1.15.1 Normal Operation. In the normal operating mode (drawing a sample from the patient sample port) valve 1 (V1), valve 2 (V2), and valve 3 (V3) are in the normally open (NO) position (See Figure 1-1). The sample moves from the patient sample port through V1 and into the gas analyzer (HP91). The gas analyzer uses infrared analysis to provide analog signals that correspond to the amount of CO2 and N2O present in the sample. Analog signals representing CO2 and N2O along with a reference signal are multiplexed, digitized and sent to the processor for manipulation, processing, and display. From the gas analyzer the sample passes to the absolute pressure and

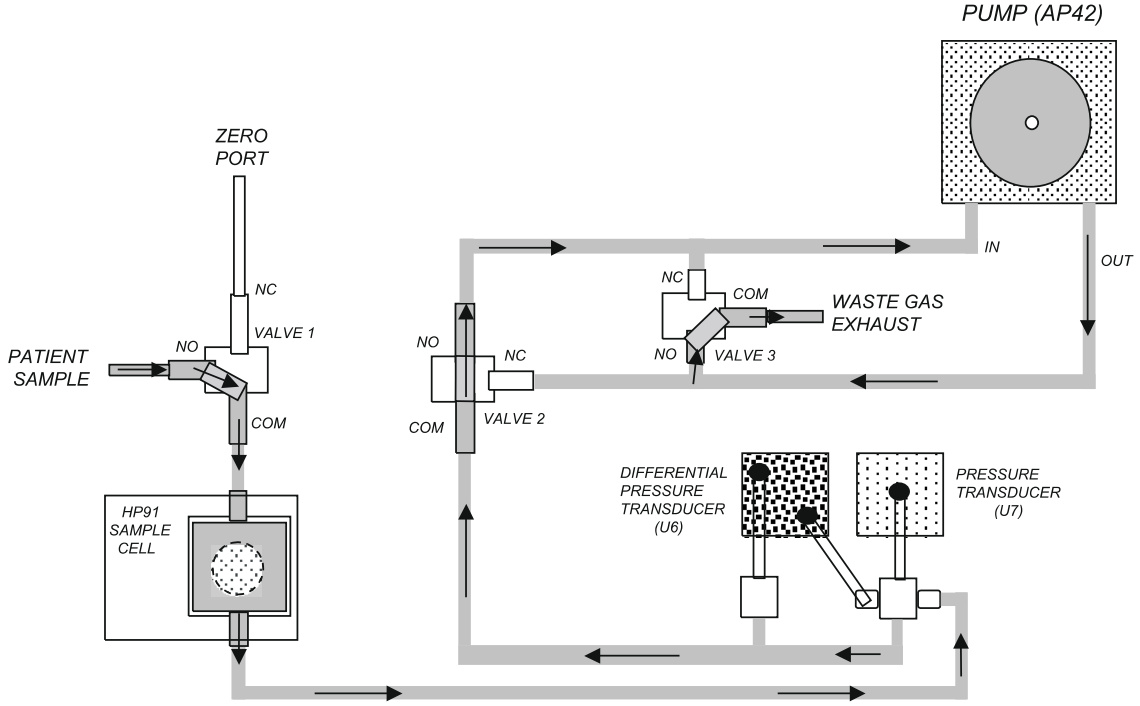


**Figure 1-1. ETCO2 Flow Diagram - Normal Operation**

differential pressure sensors. The absolute pressure circuit contains the sensor (U7), a differential amplifier (U3), and operational amplifier (U4B) and provides a signal that represents the pressure of the sample. The differential pressure circuit is comprised of the differential pressure sensor (U6) and operational amplifiers U2 and U4A. The differential pressure transducer signal represents the flow rate through the system. The absolute and differential signals are multiplexed, digitized and sent to the processor for manipulation and processing. The sample when moves through V2, through the pump, through V3 and out the waste gas exhaust port. The processor controls the pump (On/Off and Adult/Neo) and pump speed through U14 (Input/Output Interface), Q1, Q2, U1, and U5.

1.15.2 ETCO2 Zero. At various times during operation the system must be zeroed to the atmosphere in order to eliminate drift in tolerance (See Figure 1-2). During the zeroing process the processor sends a signal to Q3 which energizes V1 changing it from the NO position to the NC position. This action causes the sample to be drawn from the zero port (atmosphere) rather than from the patient sample port. The processor then establishes the zero point at atmosphere.

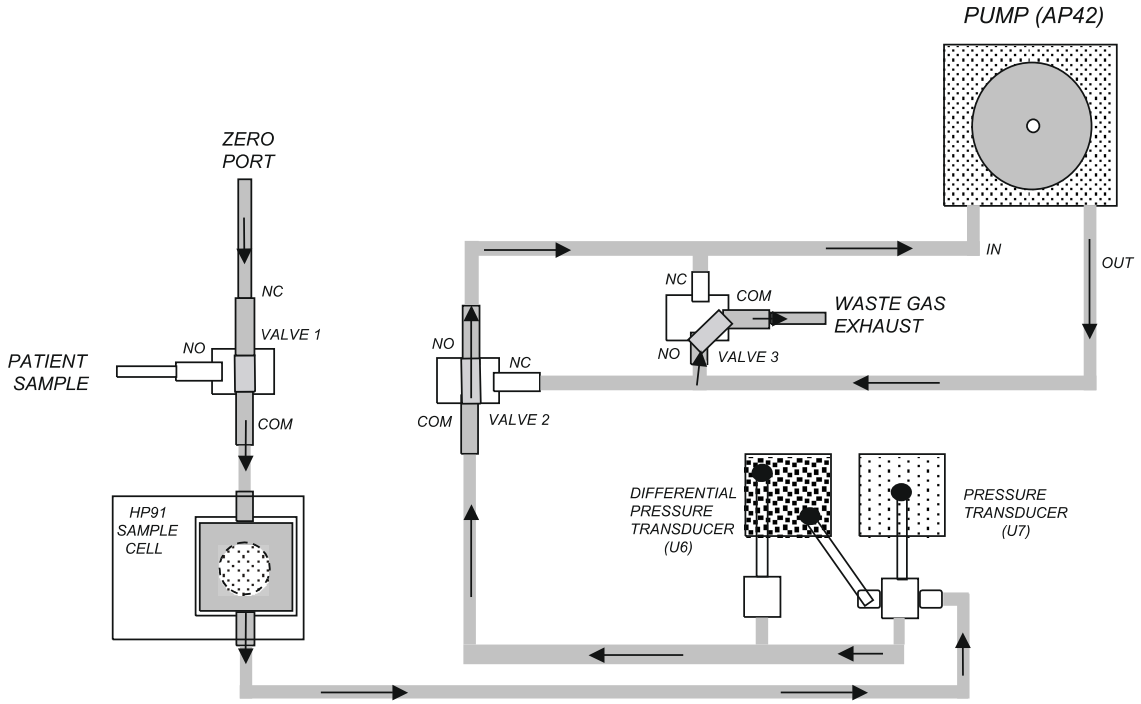


**Figure 1-2. ETCO2 Flow Diagram - Zero**

1.15.3 ETCO2 Occlusion. If the pneumatic system should become plugged with debris (occlusion), the direction of system flow is reversed in order that debris is dislodged from the system. An occlusion event (See Figure 1-3) is determined by the processor as a drop in the system flow rate as determined by the differential pressure sensor. When the processor recognizes an occlusion, a signal is sent to U14 I/O. U14 turns Q3, Q4, and Q5 on which switches V1, V2, and V3 to the NC position. This reverses the flow of the system and pushes the debris out the zero port.

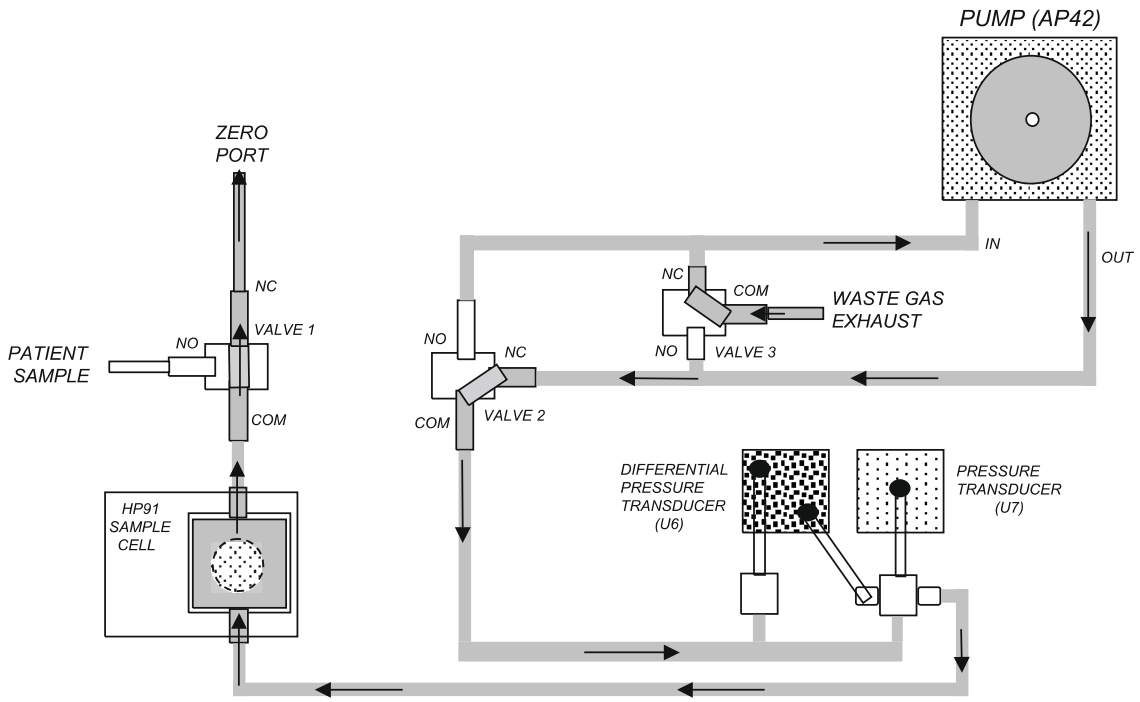


**Figure 1-3. ETCO2 Flow Diagram - Occlusion**

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# SECTION II

# CALIBRATION AND VERIFICATION

## 2.0 CALIBRATION AND VERIFICATION

2.0.1 Required Test Equipment. The following test equipment is required to perform calibration, verification and adjustment procedures on the Model **3150/3150M** monitors:

- 20 MHz Dual Channel Oscilloscope (Analog).
- Digital Multimeter (DMM) (5.5 digit accuracy or better).
- Pressure Manometer.
- Patient Simulator (ECG: 60-300 bpm, 0.5 to 2 mV amplitude, 1mV square wave at 2 Hz).
- Variable Auto Transformer (50/60Hz, 120V input, 0-250V output or equivalent).
- Variable DC Voltage Supply.
- 40 foot NIBP Hose.
- Pressure Simulator (0 to 250 mmHg).
- Extender Boards.
- Piece of Wood (2 ft. 1 x 6").
- Signal Generator (50 Ω Output Impedance).
- 49.9K Ω Resistor.
- 0.05 mm Hex Driver.

2.0.2 ETCO2 Test Equipment. The following additional test equipment is only required if the monitor contains the ETCO2 option:

- Air Flow Meter (0 to 300 mL/minute)
- Calibration Gas (10% CO2, 50% N2O, Balance N2, Invivo Research Part Number 9010F)

2.0.3 GATING Test Equipment. The following additional test equipment is only required if the monitor contains the GATING option:

- Signal Test Adapter, Invivo Research Part Number AS131.

**2.1 Turning The Monitor On.** Perform the following procedure to apply power to the monitor:

a. Turn the **AS153 AC Power Adapter** and **3150/3150M** monitor Power Switches to the ON position.

b. On the **3150/3150M** monitor Front Panel Display: verify that the following messages are displayed (alarm tone will also sound):
   (1) COMMAND LINK: LOST.
   (2) DATA LINK: UNKNOWN.

c. Turn the **Millennia® 3155MVS/3155A** monitor Power Switch to the ON position.

d. On the **3150/3150M** monitor Front Panel Display: verify that the following messages have been removed from the display:
   (1) COMMAND LINK: LOST.
   (2) DATA LINK: UNKNOWN.

e. On the **Millennia® 3155MVS/3155A** monitor, verify the following:
   (1) The lower right hand box on the Display Screen is labeled REMOTE.
   (2) Both Squares inside the Remote Box are together.
   (3) The Status Box is green (indicating proper communications have been established).

**2.2 Front Panel Control Verification.** (**See Figure 2-1**) Perform the following procedure to verify the proper operation of the Control Keys on the **3150/3150M** monitor Control Panel.

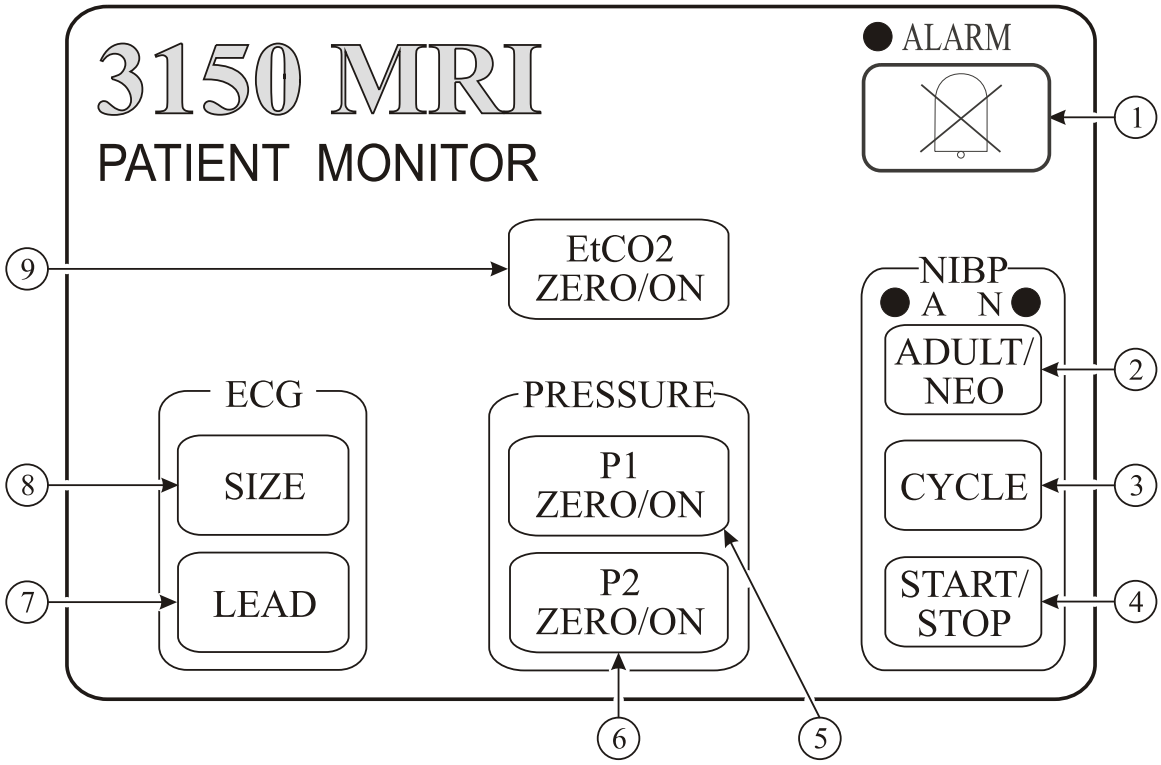


**Figure 2-1. The 3150/3150M Monitor Control Panel**

2.2.1 ECG Control Keys Verification. Perform the following procedure to verify proper operation of the ECG Control Keys:

a. **ECG LEAD Control Key.** (**Item 7**) Perform the following procedure to verify proper operation of the **ECG LEAD** Control Key:
   (1) Note the Lead displayed on the Display Screen then press the **ECG LEAD** Control Key.
   (2) Observe that the displayed Lead (noted above) changed.
   (3) Continue to press the **ECG LEAD** Control Key to verify that ECG Leads I, II (default), III, AVL, AVF, AVR and CAL (available in Stand Alone Mode only) may be selected.
   (4) Press the **ECG LEAD** Control Key until ECG Lead II is displayed on the Display Screen.

b. **ECG SIZE Control Key.** (**Item 8**) Perform the following procedure to verify proper operation of the **ECG SIZE** Control Key:
   (1) Note the Lead Size displayed on the Display Screen then press the **ECG SIZE** Control Key.
   (2) Observe that the displayed Size (noted above) changed.
   (3) Continue to press the **ECG SIZE** Control Key to verify that the following Sizes may be selected: 5, 10, 15, 20, 25, 30, 40 and A.
   (4) Press the **ECG SIZE** Control Key until A is displayed on the Display Screen.

2.2.2 ETCO2 ZERO/ON Control Key Verification. (**Item 9**) Perform the following procedure to verify proper operation of the **ETCO2 ZERO/ON** Control Key:

a. If On, turn the Remote Monitor Power Switch to the OFF position.

b. Press the **ETCO2 ZERO/ON** Control Key.

c. Verify that the ETCO2 System turns On.

d. Press the **ETCO2 ZERO/ON** Control Key.

e. Verify that the NOW ZEROING message is displayed.

f. Press and hold the **ETCO2 ZERO/ON** Control Key.

g. Verify that the ETCO2 System turns Off.

h. Release the **ETCO2 ZERO/ON** Control Key.

2.2.3 Invasive Pressure Control Keys Verification. Perform the following procedure to verify proper operation of the Invasive Pressure Control Keys:

a. **PRESSURE P1 ZERO/ON Control Key.** (**Item 5**) Perform the following procedure to verify proper operation of the **PRESSURE P1 ZERO/ON** Control Key:
   (1) Establish communication with the Remote Monitor.
   (2) Press the **PRESSURE P1 ZERO/ON** Control Key.
   (3) Verify that P1 turns OFF.
   (4) Press the **PRESSURE P1 ZERO/ON** Control Key.
   (5) Verify that P1 turns ON.

b. **PRESSURE P2 ZERO/ON Control Key.** (**Item 6**) Perform the following procedure to verify proper operation of the **PRESSURE P2 ZERO/ON** Control Key:
   (1) Establish communication with the Remote Monitor.
   (2) Press the **PRESSURE P2 ZERO/ON** Control Key.
   (3) Verify that P2 turns OFF.
   (4) Press the **PRESSURE P2 ZERO/ON** Control Key.
   (5) Verify that P2 turns ON.

2.2.4 ALARM Control Key Verification. (**Item 1**) Perform the following procedure to verify proper operation of the **ALARM** Control Key:

a. Establish communication with the Remote Monitor.

b. Create an alarm violation on the Remote Monitor.

c. Once the **3150/3150M** monitor begins to alarm, press the **ALARM** Control Key.

d. Verify that the Alarm Tone stops sounding.

2.2.5 NIBP Control Keys Verification. Perform the following procedure to verify proper operation of the NIBP Control Keys:

a. **NIBP ADULT/NEO Control Key.** Perform the following procedure to verify proper operation of the **NIBP ADULT/NEO** Control Key:
   (1) Observe which LED is lit above the **NIBP ADULT/NEO** Control Key.
   (2) Press the **NIBP ADULT/NEO** Control Key.
   (3) Verify that the LED which was previously lit goes out and the other LED lights up.
   (4) Verify that the Patient Mode (in the top right corner of the Display Screen) corresponds to the setting indicated by the lit LED.
   (5) Press the **NIBP ADULT/NEO** Control Key.
   (6) Verify that the original LED is lit and that the top right corner of the Display Screen changes to indicate the new selection.

b. **NIBP CYCLE Control Key.** Perform the following procedure to verify proper operation of the **NIBP CYCLE** Control Key:
   (1) Press the **NIBP CYCLE** Control Key.
   (2) Verify that the NIBP Automatic Reading Time Interval changes.
   (3) Press the **NIBP CYCLE** Control Key until the monitor has cycled through all the available settings (MANUAL, CYC=1, CYC=2, CYC=3, CYC=5, CYC=10, CYC=15, CYC=20, CYC=30, CYC=45 and CYC=60).

c. **NIBP START/STOP Control Key.** Perform the following procedure to verify proper operation of the **START/STOP** Control Key:
   (1) Press the **START/STOP** Control Key.
   (2) Verify that the NIBP Pump turns on as the system initiates a reading cycle.
   (3) Press the **START/STOP** Control Key.
   (4) Verify that the NIBP Pump turns off as the system aborts the active reading cycle.

**2.3 Patient Parameter Verification.** Perform the following procedure to verify proper operation of all installed patient parameters.

2.3.1 ECG Verification. Perform the following procedure to verify proper operation of the ECG system:

a. Connect a ECG Patient Simulator to the ECG input on the **3150/3150M** monitor Parameter Input Panel.

b. Select **HR SOURCE** to **ECG** on the remote monitor.

c. Setup the **3150/3150M** monitor as follows:
   (1) Set the ECG Size to 10.
   (2) Set the ECG Lead to II.
   (3) Select Adult Mode.

d. Set the Patient Simulator to output a 2 mV QRS pulse at 60BPM's.

e. Verify the following (on both the **3150/3150M** monitor and the remote monitor):
   (1) Trace A shows a waveform train of moving QRS pulses without jittering.
   (2) Trace A numerics indicate an ECG count of 60 BPM.
   (3) The QRS Symbol (flashing heart) is present.
   (4) QRS Heart Rate Tone is present with NO double tones.

f. Repeat substep e. for all Leads (except CAL).

g. Set the Patient Simulator to output a 2 mV QRS pulse at 120BPM's.

h. Verify the following (on both the **3150/3150M** monitor and the remote monitor):
   (1) Trace A shows a waveform train of moving QRS pulses without jittering.
   (2) Trace A numerics indicate an ECG count of 120 BPM.
   (3) The QRS Symbol (flashing heart) is present.
   (4) QRS Heart Rate Tone is present with NO double tones.

i. Repeat substep h. for all Leads (except CAL).

j. Set the Patient Simulator to output a 2 mV QRS pulse at 240 BPM's.

k. Verify the following:
   (1) Trace A shows a waveform train of moving QRS pulses without jittering.
   (2) Trace A numerics indicate an ECG count of 240 BPM.
   (3) The QRS Symbol (flashing heart) is present.
   (4) QRS Heart Rate Tone is present with NO double tones.

l. Repeat substep k. for all Leads (except CAL).

m. Set the Patient Simulator to output a 2 mV QRS pulse at 300BPM's.

n. Verify all Leads display "**OVR**."

o. On the **Millennia® 3155MVS/3155A** monitor, set the ECG Lead to CAL.

p. When the waveform is stabilized, verify an ECG count of 146 ±1.

q. Disconnect the Patient Simulator from the monitor Parameter Input Panel.

r. **ECG Lead Fail Verification.** Perform the following procedure to verify proper operation of the ECG Lead Fail Circuitry:
   (1) Connect a ECG Patient Simulator to the ECG input on the **3150/3150M** monitor Parameter Input Panel.
   (2) Set the Patient Simulator to output a 1.0 mV QRS pulse at 60BPM'S (NORMAL SINUS mode).
   (3) Select ECG Lead I.
   (4) Remove one wire at a time (that pertains to the selected lead) until all the Lead Wires have been tested. In each case verify that **within 30 seconds** of removal of each wire that the "**LEAD FAIL**" message appears to the right of the selected lead at the top left of the display screen and that there is no QRS Tone or Number displayed. Verify that the trace recovery time is within 30 seconds of Lead Fail Correction.
   (5) Select each lead in order and perform substep 4 until all the leads (except CAL) have been verified.
   (6) Disconnect the Patient Simulator from the monitor front panel.

s. **ECG Neonate Lead Fail Verification.** Perform the following procedure to verify proper operation of the ECG Neonatal Lead Fail Circuitry:
   (1) Connect a ECG Patient Simulator to the ECG input on the monitor front panel.
   (2) Set the Patient Simulator to output a 0.3 mV QRS pulse at 60BPM'S (NORMAL SINUS mode).
   (3) Set the **3150/3150M** monitor ECG Lead to III.
   (4) Verify that, while still in Adult Mode, there is no QRS Tone or Number displayed and the **ASYSTOLE** message is displayed in the ECG message area.

(5) Press the **NIBP ADULT/NEO** Control Key to select the Neonatal Mode of operation.
(6) Verify a QRS count of "60," a flashing heart symbol and audible tone, and no **LEAD FAIL** message in the ECG message area.
(7) Remove one wire at a time (that pertains to the selected lead) until all the Lead Wires have been tested. In each case verify that **within 30 seconds** of removal of each wire that the "**LEAD FAIL**" message appears to the right of the selected lead at the top left of the display screen and that there is no QRS Tone or Number displayed. Verify that the trace recovery time is within 30 seconds of Lead Fail Correction.
(8) Select each lead in order and perform substep 7 until all the leads (except CAL) have been verified.
(9) Disconnect Patient Simulator.

t. **QRS Detect Verification.** Perform the following procedure to verify proper operation of the QRS Detection Circuitry:
(1) Connect a ECG Patient Simulator to the ECG input on the **3150/3150M** monitor Parameter Input Panel.
(2) Set the Patient Simulator to output a 0.5 mV QRS pulse at 60BPM's (NORMAL SINUS mode).
(3) Set the **Millennia® 3155MVS/3155A** monitor to Adult Mode with Lead II selected.
(4) Select **HR SOURCE** to **ECG** on the remote monitor.
(5) Setup the **3150/3150M** monitor as follows:
(a) Set the ECG Size to 10.
(b) Set the ECG Lead to II.
(c) Select Adult Mode.
(6) Verify the following (on both the **3150/3150M** monitor and the remote monitor):
(a) Trace A shows a waveform train of moving QRS pulses without jittering.
(b) Trace A numerics indicate an ECG count of 60 BPM.
(c) The QRS Symbol (flashing heart) is present.
(d) QRS Heart Rate Tone is present with NO double tones.
(7) Disconnect the Patient Simulator from the Parameter Input Panel.

2.3.2 NIBP Verification. Perform the following procedure to verify proper operation of the NIBP system.

a. Press and hold the **ALARM** Control Key for approximately 3 seconds to display the NIBP Diagnostics Screen.

**NOTE**
The diagnostics mode is limited to 3.5 minutes. At that time the NIBP Diagnostics and System Voltages return to “0”.

b. Verify the following on the NIBP Diagnostics Screen:
(1) DC = 6 (±1).
(2) AC = 80 (±1).

c. Verify the following System Voltages on the NIBP Diagnostics Screen:
(1) +5V = 5.0 (±0.1).
(2) +12 = 13 (±0.5).
(3) -12 = 12 (±0.5).

d. Press the **NIBP ADULT/NEO** Control Key to select NEO.

e. Verify the following on the NIBP Diagnostics Screen.
   (1) DC = 6 (±1).
   (2) AC = 80 (±1).

f. Press the **NIBP ADULT/NEO** Control Key to select ADULT.

g. Connect Pressure Tester (Deadweight or Manometer) to the NIBP Sense Port on the monitor Parameter Input Panel (NIBP left port).

h. Perform the Pressure Transducer Test as follows:
   (1) Set the Pressure Tester for 200 mmHg.
   (2) Verify on NIBP Diagnostics Screen, DC = 206 (±1).
   (3) Set the Pressure Tester for 150 mmHg.
   (4) Verify on NIBP Diagnostics Screen, DC = 156 (±1).
   (5) Set the Pressure Tester for 100 mmHg.
   (6) Verify on NIBP Diagnostics Screen, DC = 106 (±1).
   (7) Set the Pressure Tester for 50 mmHg.
   (8) Verify on NIBP Diagnostics Screen, DC = 56 (±1).
   (9) Set the Pressure Tester for 0 mmHg.
   (10) Verify on NIBP Diagnostics Screen, DC = 6 (±1).
   (11) Set the Pressure Tester for 50 mmHg.
   (12) Verify on NIBP Diagnostics Screen, DC = 56 (±1).
   (13) Set the Pressure Tester for 100 mmHg.
   (14) Verify on NIBP Diagnostics Screen, DC = 106 (±1).
   (15) Set the Pressure Tester for 150 mmHg.
   (16) Verify on NIBP Diagnostics Screen, DC =156 (±1).
   (17) Set the Pressure Tester for 200 mmHg.
   (18) Verify on NIBP Diagnostics Screen, DC = 206 (±1).
   (19) Set the Pressure Tester for 250 mmHg.
   (20) Verify maximum pressure on NIBP Diagnostics Screen, DC = 255 (+0/-1).
   (21) Release the pressure and disconnect the Pressure Tester from the Sense Port.

i. Perform Pneumatic Leak Test as follows:
   (1) Connect a 40 foot leak hose to the NIBP Ports on the Parameter Input Panel.
   (2) While in Diagnostics Mode, press the **NIBP START/STOP** Control Key.

**NOTE**

The pump will start up automatically and cycle approximately every 30 seconds. A difference of 10 or more between the "INIT" and "CUFF" would be considered a failure and will register in the "INIT" window after each cycle.

   (3) Verify a minimum of 2 Leak Test Cycles with no failures.
   (4) Press the **ALARM** Control Key to exit the Diagnostics Mode.

j. Perform Over Pressure Verification as follows:
   (1) Connect a manometer to the NIBP Inflate Port (located on the monitor Parameter Input Panel - NIBP right port).
   (2) If the patient selection is NEO, press the **NIBP ADULT/NEO** Control Key to select ADULT.
   (3) Press the **NIBP START/STOP** Control Key to start up the pump.
   (4) Slowly close the bleed screw on the manometer hand bulb for a pressure rate of 50 mmHg per second until the manometer reaches 270 mmHg (±5).

(5) Verify that the pump shuts itself off when the above limits are violated and an "OVR-PRES" warning message is displayed in the lower left hand corner of the screen.
(6) Disconnect the manometer from the NIBP Inflate Port.

k. Perform Leak Time-Out Verification as follows:
(1) With nothing connected to the NIBP Ports on the monitor front panel, press the **NIBP START/STOP** Control Key.
(2) Verify that the pump shuts off after 6 seconds ±1.5 seconds and that the error message "TIME OUT" is displayed in the lower left corner of the screen.

l. Perform Calibrate Error Verification as follows:
(1) Connect the Manometer to the NIBP Sense Port (located on the monitor Parameter Input Panel - NIBP left port).
(2) Inflate the Manometer to 15 mmHg.
(3) Press the **NIBP START/STOP** Control Key.
(4) Verify that the pump does not start up.
(5) Verify that the error message "CALIB" is displayed in the lower left corner of the screen within 15 seconds ±1 second.
(6) Disconnect the manometer from the NIBP Sense Port.

m. Perform Normal Blood Pressure Reading Verification as follows:

**NOTE**
Perform the substeps below using an NIBP Analyzer if available.

(1) Perform Adult Verification as follows:
(a) Connect an Adult Cuff (IRI Part Number 9070E) to the NIBP Ports on the monitor Parameter Input Panel.
(b) Place the Adult Cuff on arm.
(c) If Adult mode is not selected, press the **NIBP ADULT/NEO** Control Key to select Adult.
(d) Press the **NIBP START/STOP** Control Key.
(e) Verify that the Cuff inflates to 170 mmHg before the pump stops and the system begins to release pressure through the bleed valves.
(f) When the blood pressure determination is complete, verify that the Systolic, Mean and Diastolic Blood Pressure numerics are present in the lower left of the screen (in the NIBP Icon).
(g) Remove the Cuff from the arm.
(h) Attach Cuff to a solid object (approximately arm size), press the **NIBP START/STOP** Control Key and verify a NIBP determination of 0 for Systolic, Mean and Diastolic.
(I) Disconnect the Cuff from the NIBP Ports on the monitor front panel.

(2) Perform Neonatal Verification as follows:
(a) Connect a Neonatal Cuff (IRI Part Number AN01A or AN02A) to your finger.
(b) Connect the Neonatal Cuff to the NIBP Ports on the monitor front panel.
(c) Press the **NIBP ADULT/NEO** Control Key to select Neo.
(d) Hold hand with cuffed finger above shoulder height (to ensure blood pressure reading below 100 mmHg) and press the **NIBP START/STOP** Control Key.
(e) Verify that the Cuff inflates to 110 mmHg before the pump stops and the system begins to release pressure through the bleed valves.

(f) When the blood pressure determination is complete, verify that the Systolic, Mean and Diastolic Blood Pressure numerics are present in the lower left of the screen (in the NIBP Icon).
(g) Remove the Cuff from the finger.
(h) Attach Cuff to a solid object (approximately finger size), press the **NIBP START/STOP** Control Key and verify a NIBP determination of 0 for Systolic, Mean and Diastolic.
(I) Disconnect the Cuff from the NIBP Ports on the monitor front panel.
(j) Return the Patient Selection to Adult by pressing **NIBP ADULT/NEO** Control Key.

n. Perform the NIBP Range and Accuracy Verification as follows:

**NOTE**
Perform the substeps below using an NIBP Analyzer if available.

(1) Adult Range and Accuracy Verification:

| Systolic | Diastolic | Mean | Tolerance |
|---|---|---|---|
| 45 | 15 | (25) | ±5mmHg |
| 80 | 50 | (62) | ±5mmHg |
| 120 | 80 | (90) | ±10mmHg |
| 150 | 100 | (115) | ±10mmHg |
| 245 | 185 | (205) | ±10mmHg |

(2) Neonatal Range and Accuracy Verification:

| Systolic | Diastolic | Mean | Tolerance |
|---|---|---|---|
| 45 | 15 | (25) | ±5mmHg |
| 80 | 50 | (62) | ±5mmHg |
| 120 | 80 | (90) | ±10mmHg |
| 150 | 100 | (115) | ±10mmHg |
| 190 | 140 | (155) | ±10mmHg |

**NOTE**
The uncertainty specifications of the NIBP Analyzer must be added to the **3150/3150M** monitor tolerances for proper accuracy verification.

2.3.3 SpO2 Verification. Perform the following procedure to verify proper operation of the SpO2 System:

a. Connect SpO2 Probe to the SpO2 connector on the monitor Parameter Input Panel.

b. If necessary, press the **PRESSURE P2 ZERO/ON** Control Key to turn off P2.

c. Place your finger into the probe and, after the monitor waveform display levels out, verify the following:
1) SpO2 Pulse occurs with the operators heart count.
2) The SpO2 % is within reasonable limits for the operator (96 to 100).
3) The SpO2 waveform is smooth with no steps.

d. Remove the probe from your finger.

e. Verify the accuracy of Oxygen Saturation Value with Invivo probes as follows:

**NOTE**
Perform the measurements below using an SpO2 simulator if available.

| Oxygen Saturation | Tolerance |
|---|---|
| 90-100% | ±2% |
| 80-90% | ±2.2% |
| 70-80% | ±2.5% |
| 60-70% | ±3% |

**NOTE**
The uncertainty specifications of the SpO2 Simulator must be added to the **3150/3150M** monitor tolerances for proper accuracy verification.

f. Disconnect the SpO2 probe from the monitor Parameter Input Panel.

2.3.4 ETCO2 Verification. (If the ETCO2 option is installed) Perform the following to verify proper operation of the ETCO2 system:

a. On the **Millennia® 3155MVS/3155A** monitor, setup up the ETCO2 system as follows:
   (1) Press the **SETUP** Control Key.
   (2) Turn the Rotary Knob to highlight the **PARAMETER SELECTION** menu selection.
   (3) Press the Rotary Knob to select **PARAMETER SELECTION**.
   (4) Turn the Rotary Knob to highlight the **ETCO2** menu selection.
   (5) Press the Rotary Knob to select **ETCO2**.
   (6) Turn the Rotary Knob to highlight the **ETCO2 ON** parameter selection.
   (7) Press the Rotary Knob to select **ETCO2 ON**.
   (8) Press the **NORMAL SCREEN** Control Key.
   (9) Wait 15 minutes (for ETCO2 to Warm Up) before proceeding to substep b.

b. Perform CO2 Occlusion Test as follows:
   (1) Place your finger over the ETCO2 Port on the monitor front panel and verify the following:
      (a) The message “OCCLUSION” appears at the bottom right corner of the display screen.
      (b) The pump motor speed increases in an attempt to clear the occlusion.
   (2) Remove your finger from the ETCO2 Port.
   (3) Press the **NIBP ADULT/NEO** Control Key to select NEO (this changes the air flow from High to Low).
   (4) Place your finger over the ETCO2 Port on the monitor front panel and verify the following:
      (a) The message “OCCLUSION” appears at the bottom right corner of the display screen.
      (b) The pump motor speed increases in an attempt to clear the occlusion.
   (5) Remove your finger from the ETCO2 Port.

c. Perform Zero Calibration for Low Flow as follows:
   (1) Press the **ETCO2 ZERO/ON** Control Key.
   (2) Verify that message "ZEROING" appears at the bottom right corner of the Display Screen.

(3) Connect the CO2 CAL GAS (IRI Part Number 9010F) aerosol can to the ETCO2 Port on the Parameter Input Panel.
(4) Simulate breathing pattern (by pressing and releasing the nozzle of the can) and verify the following:
    (a) ETCO2 = 76 (±3).
    (b) N20 reading stabilizes to 50 (±3).
    (c) A waveform appears in the ETCO2 Trace area.
(5) Disconnect the Calibration Gas from the ETCO2 Port.
(6) Connect Flow Meter to the ETCO2 Port and verify an air flow of 150 ml (±5ml).
(7) Disconnect the Flow Meter.

d. Perform Zero Calibration for High Flow as follows:
(1) Press the **NIBP ADULT/NEO** Control Key to select the Adult Mode (this changes the air flow from Low to High).
(2) Connect Flow Meter to the ETCO2 Zero Port on the lower back column of the monitor.
(3) Press the **ETCO2 ZERO/ON** Control Key and verify an air flow of greater than 200 ml.
(4) Disconnect the Flow Meter from the ETCO2 Zero Port and connect to the ETCO2 Waste Gas Exhaust Port on the bottom front of the monitor base.
(5) Verify a positive air flow of greater than 230 ml at all times including during zeroing.
(6) Disconnect the Flow Meter.
(7) Connect the CO2 CAL GAS (IRI Part Number 9010F) aerosol can to the ETCO2 Port.
(8) Simulate breathing pattern (by pressing and releasing the nozzle of the can) and verify the following:
    (a) ETCO2 = 76 (±3).
    (b) N20 reading stabilizes to 50 (±3).
    (c) A waveform appears in the ETCO2 Trace area.
(9) Disconnect the Calibration Gas.
(10) Connect Flow Meter to the ETCO2 Port on the monitor Parameter Input Panel and verify an air flow of 230 ml (±5 ml).

2.3.5 Invasive Pressure Verification. (If the Invasive Pressure option is installed) Perform the following procedure to verify the proper operation of the Invasive Pressure monitoring system:

a. Connect the output of a Pressure Simulator to the P1 connector on the monitor front panel.

b. Set the Pressure Simulator to output 000 mmHg with the Zero switch on.

c. Turn on P1 and set zero by pressing the **PRESSURE P1 ZERO/ON** Control Key.

d. Verify the P1 numerics indicate Zero ±1 count.

e. Adjust the Pressure Simulator as follows:
(1) Set the Pressure Simulator Zero switch to "+."
(2) Set the Pressure Simulator to output 240.

f. Verify that the P1 numerics increase in a positive direction toward 240.

g. Set the Pressure Simulator Zero switch to Zero.

h. Verify that the P1 numerics return to zero.

i. Verify the Invasive Pressure at different levels as follows:
   (1) Set the Pressure Simulator Zero switch to "+."
   (2) Set the Pressure Simulator to output 50.
   (3) Verify that the P1 numerics indicate 50 ±1.
   (4) Set the Pressure Simulator to output 100.
   (5) Verify that the P1 numerics indicate 100 ±1.
   (6) Set the Pressure Simulator to output 150.
   (7) Verify that the P1 numerics indicate 150 ±1.
   (8) Set the Pressure Simulator to output 200.
   (9) Verify that the P1 numerics indicate 200 ±2.
   (10) Set the Pressure Simulator to output 240.
   (11) Verify that the P1 numerics indicate 240 ±2.
   (12) Set the Pressure Simulator to output 250.
   (13) Verify that the P1 numerics indicate 250 alternated with the **OVR** message.

j. (If P2 is installed) Repeat substeps a through i.

2.3.6 Gating Verification. Perform the following procedure to verify proper operation of the Gating Circuitry:

a. Setup the Oscilloscope as follows:
   - Vertical mode: CH1
   - Coupling: DC
   - Trigger Source: CH1
   - Scope Probe: 10X
   - Vertical Sensitivity: 0.1V/DIV
   - Trigger: Normal, Negative Slope
   - Time Base: 5msec

b. Connect ECG Patient Simulator to the ECG Port on the **3150/3150M** monitor Parameter Input Panel.

c. Set the Patient Simulator for 120 BPM.

d. On the **Millennia® 3155MVS/3155A** monitor, select **HR SOURCE** to **QRS**.

e. Connect the Oscilloscope as follows:
   (1) Connect Probe to Pin 1 on the Gating connector.
   (2) Connect Probe Ground to Pin 6 on the Gating connector.

f. On the Oscilloscope: verify that the amplitude is greater than 3.3 $V_{pp}$ and less than 5.0 $V_{pp}$ with a negative pulse of 13 msec ± 3msec (3150 monitor) or 10 msec ± 1msec (3150M monitor).

g. Connect an SpO2 Probe to the SpO2 Port on the **3150/3150M** monitor Parameter Input Panel.

h. On the **Millennia® 3155MVS/3155A** monitor, select **HR SOURCE** to **SPO2**.

i. Place finger into the SpO2 probe.

j. On the Oscilloscope: verify that the amplitude is greater than 3.3 $V_{pp}$ and less than 5.0 $V_{pp}$ with a negative pulse of 13 msec ± 3msec (3150 monitor) or 10 msec ± 1msec (3150M monitor).

k. Remove finger from the probe.

l. On the **Millennia® 3155MVS/3155A** monitor, select **HR SOURCE** to **ECG**.

m. Remove the Oscilloscope Probe from Pin 1 and connect to Pin 2.

n. On the Oscilloscope: verify that the amplitude is greater than 3.3 $V_{pp}$ and less than 5.0 $V_{pp}$ with a positive pulse of 13 msec ± 3msec (3150 monitor) or 10 msec ± 1msec (3150M monitor).

o. On the **Millennia® 3155MVS/3155A** monitor, select **HR SOURCE** to **SPO2**.

p. Place finger into the SpO2 probe.

q. On the Oscilloscope: verify that the amplitude is greater than 3.3 $V_{pp}$ and less than 5.0 $V_{pp}$ with a positive pulse of 13 msec ± 3msec (3150 monitor) or 10 msec ± 1msec (3150M monitor).

r. Remove finger from the probe.

s. Remove the Oscilloscope Probe from Pin 2 and connect to Pin 3.

t. Connect the output of a Pressure Simulator to the P1 connector on the monitor front panel.

u. Set the Pressure Simulator to output 000 mmHg with the Zero switch on.

v. Turn on P1 and set zero by pressing the **PRESSURE P1 ZERO/ON** Control Key.

w. Verify the P1 numerics indicate Zero ±1 count and a positive pulse of approximately 15 ms width is displayed on the oscilloscope.

x. Adjust the Pressure Simulator as follows:
   (1) Set the Pressure Simulator Zero switch to "+."
   (2) Set the Pressure Simulator to output 100.

y. Verify the P1 numerics indicate 100 ±1 count and a positive pulse of approximately 120 ms width is displayed on the oscilloscope.

z. Remove the Oscilloscope Probe from Pin 3 and connect to Pin 4.

aa. Verify the P1 numerics indicate 100 ±1 count and a positive pulse of approximately 120 ms width is displayed on the oscilloscope.

ab. Set the Pressure Simulator Zero switch to Zero.

ac. Verify the P1 numerics indicate Zero ±1 count and a positive pulse of approximately 15 ms width is displayed on the oscilloscope.

ad. Remove the Oscilloscope Probe from Pin 4 and connect to Pin 11.

ae. Verify the P1 waveform on the **3150/3150M** monitor is similar to the waveform displayed on the oscilloscope.

af. Set the Pressure Simulator Zero switch to "+" (output at 100).

ag. Verify the P1 waveform on the **3150/3150M** monitor is similar to the waveform displayed on the oscilloscope.

ah. Remove the Oscilloscope Probe from Pin 11 and connect to Pin 5.

ai. Connect the CO2 CAL GAS (IRI Part Number 9010F) aerosol can to the ETCO2 Port.

aj. Simulate breathing pattern (by pressing and releasing the nozzle of the can) at a rate of approximately 15 BPM and verify that a negative gating pulse is displayed on the oscilloscope.

ak. Remove the Oscilloscope Probe from Pin 5 and connect to Pin 12.

al. Simulate breathing pattern (by pressing and releasing the nozzle of the can) at a rate of approximately 15 BPM and verify that the RESP waveform on the **3150/3150M** monitor is similar to the waveform displayed on the oscilloscope.

am. Remove the Oscilloscope Probe from Pin 12 and connect to Pin 7.

an. Place finger into the SpO2 probe.

ao. On the Oscilloscope: verify a positive pulse of 18 msec ± 2msec.

ap. Remove the Oscilloscope Probe from Pin 7 and connect to Pin 8.

aq. On the Oscilloscope: verify a negative pulse of 18 msec ± 2msec.

ar. Remove finger from the probe.

as. Disconnect SpO2 probe from the Parameter Input Panel.

at. Disconnect oscilloscope and connect the DMM as follows:
(1) Connect the positive (+) lead to Pin 14.
(2) Connect the negative (-) lead to Pin 6.

au. Verify a reading of 2.5 Vdc ±0.5 Vdc on the DMM.

av. Disconnect the DMM.

aw. On the **Millennia® 3155MVS/3155A** monitor, select **HR SOURCE** to **QRS**.

ax. On the Oscilloscope: set trigger to Auto Mode, switch Vertical Sensitivity to 0.1 mV/Div and time base to 0.2 seconds (0.25 seconds if using a digital oscilloscope).

ay. Connect the Oscilloscope as follows:
(1) Connect Probe to Pin 10.
(2) Connect Probe Ground to Pin 6.

az. Verify 1.0 $V_{pp}$ ±0.25 $V_{pp}$ QRS waveform (this waveform must be similar to the waveform that appears on the **Millennia® 3155MVS/3155A** monitor and **3150/3150M** monitor Display Screens.

ba. Connect the AS131 Gating Interface Box to Channel 1 on the Oscilloscope with the Probe connected to the other end of the interface box.

bb. Change the Oscilloscope Time Base to 0.2 seconds, switch the Probe to 1X and change the Vertical Sensitivity to 1 mV/Division (or the lowest amplitude setting for the scope used).

bc. Remove Oscilloscope Probe from Pin 10 and connect to Pin 9.

bd. Verify a 1.0 $mV_{pp}$ ±0.25 $V_{pp}$ QRS waveform.

be. Switch Oscilloscope Vertical Sensitivity to 20 mV/Division and Time Base to 0.2 Seconds.

bf. Connect SpO2 Probe to the **3150/3150M** monitor Parameter Input Panel.

bg. Remove Oscilloscope Probe from Pin 9 and connect to Pin 13.

bh. Place finger into the SpO2 probe.

bi. Verify approximately 20 $mV_{pp}$ (±10 $mV_{pp}$) pulse signal waveform similar to the waveform displayed on the **Millennia® 3155MVS/3155A** monitor and **3150/3150M** monitor Display Screens.

bj. Remove finger from the probe.

bk. Disconnect Oscilloscope and SpO2 probe.

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# SECTION III

# DISASSEMBLY PROCEDURES

## 3.0 DISASSEMBLY PROCEDURES.

3.0.1 Required Tools. The following tools are required to disassemble this monitor:

- 1/4" Flathead Screwdriver
- #1 Phillips Head Screwdriver
- #1 Phillips Head Screwdriver
- Small Flathead Screwdriver

**NOTE**

RF SHIELDING: For proper operation within the MRI area, this Monitor is constructed with extensive RF shielding to contain and prevent leakage of internal RF frequencies. Care should be taken during disassembly and assembly to ensure that the EMI gaskets are not damaged. Any worn or damaged EMI gaskets should be replaced to ensure integrity of the RF seal.

**3.1 Printed Circuit Board and Battery Access.** Perform substep a. below for monitors with a serial number of 115 or below and substep b for monitors with a serial number of 116 or above (serial numbers are approximate, substep a is for monitors where the column bolts in and substep b is for monitors where the column is held in place by two screws up from the base bottom).

a. Perform the following procedure to access the internal Printed Circuit Boards and Batteries:
   (1) Remove power from the **3150/3150M** monitor by disconnecting it from the AC153 AC Power Adapter.
   (2) Remove the 53 screws from the base covers.
   (3) Slide the front cover forward and the back cover to the rear.
   (4) Remove the front and back covers.

b. Perform the following procedure to access the internal Printed Circuit Boards and Batteries:
   (1) Remove power from the **3150/3150M** monitor by disconnecting it from the AC153 AC Power Adapter.
   (2) Carefully place monitor on its side.
   (3) Remove the two (2) screws that secure the column assembly from the base bottom.
   (4) Return monitor to its upright position.
   (5) Lift the column assembly from the base.
   (6) Remove the EtCO2 Zero Filter.
   (7) Remove the 26 screws from the base cover.
   (8) Remove the base cover.

3.1.1 AS145 Electronics Assembly (Card Cage) Removal. (**See Figure 3-1**) Perform the following procedure to remove the AS145 Electronics Assembly (Card Cage) from the monitor base:

a. Perform Paragraph 3.1.

b. Disconnect Battery Power cable from AB76/AB152 P5 (Power Supply Board).

c. Loosen the six (6) retaining screws on the AS145 Electronics Assembly (Card Cage).

d. Lift the AS145 Assembly out of the monitor base (support this assembly with a wooden board placed across the top of the base).

e. Remove the Rear Card Cage Bracket.

f. Remove the Top Brace.

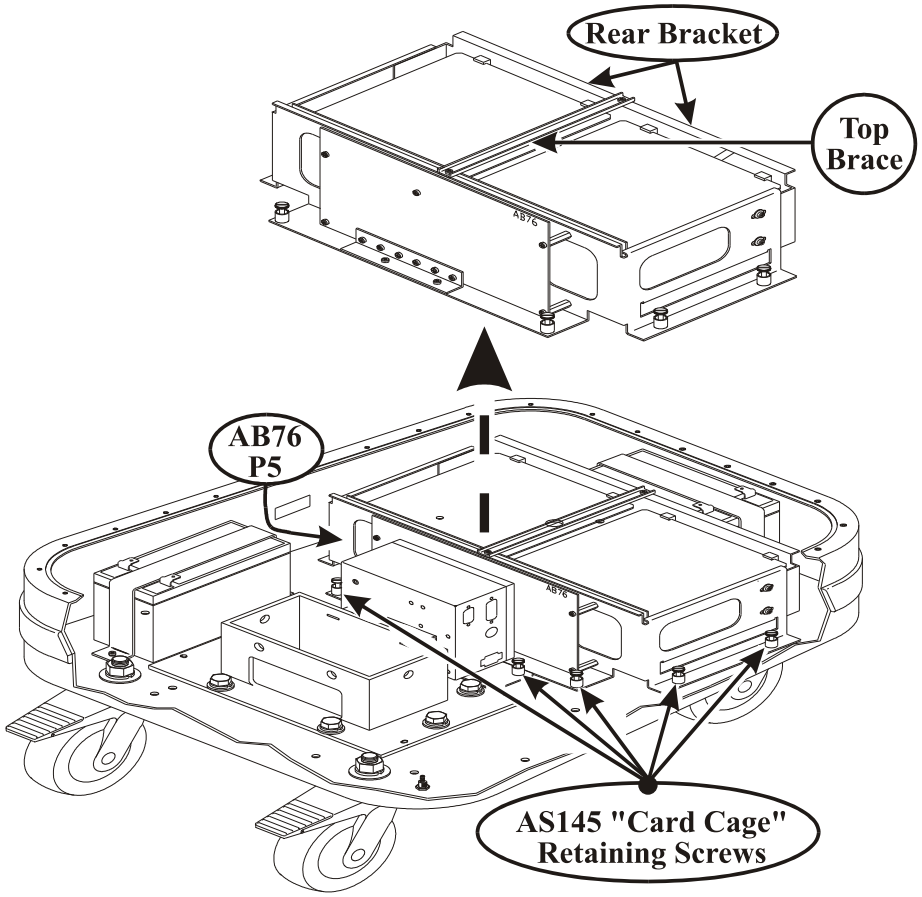



**Figure 3-1. Card Cage Removal Diagram**

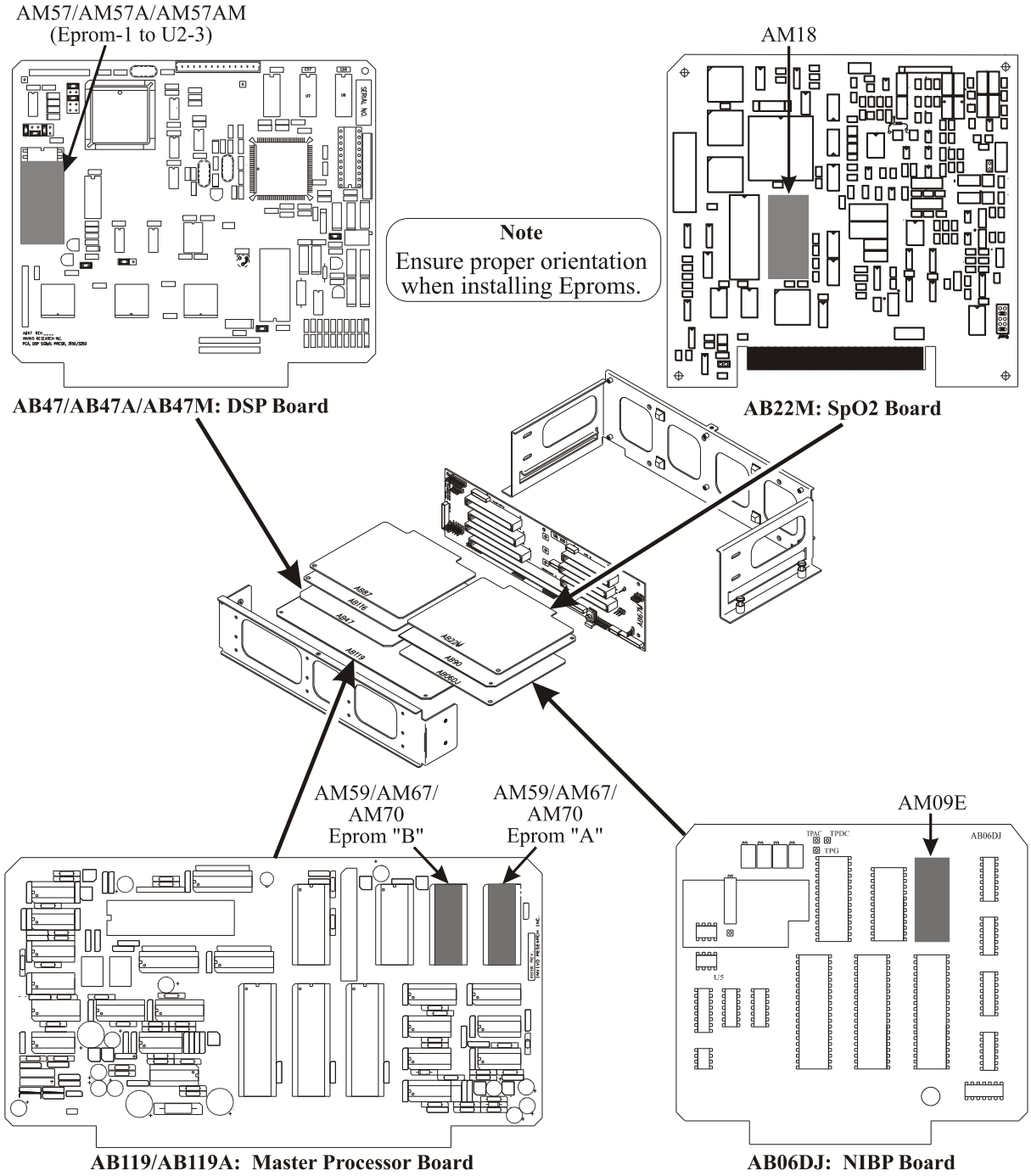



**Figure 3-2. Software Location Diagram (AB06DJ, AB22M, AB47 and AB119)**

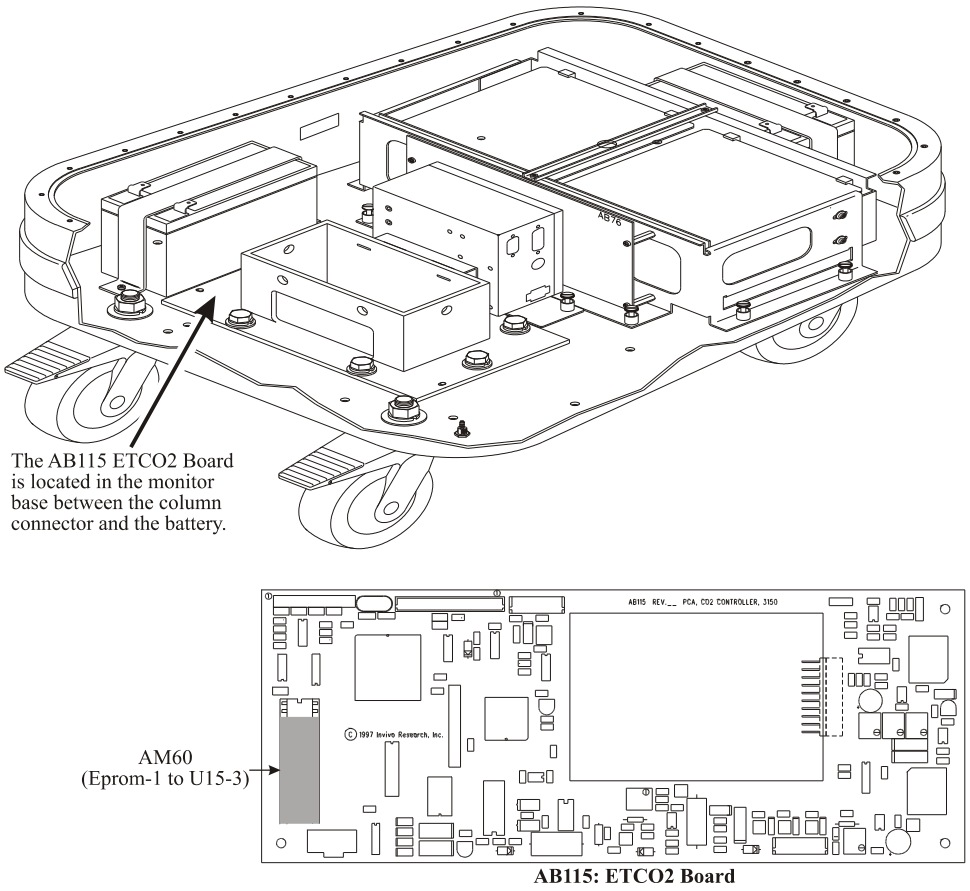

The AB115 ETCO2 Board is located in the monitor base between the column connector and the battery.
AM60
(Eprom-1 to U15-3)
AB115 REV.__ PCA, CO2 CONTROLLER, 3150
© 1997 Invivo Research, Inc.
AB115: ETCO2 Board

**Figure 3-3. Software Location Diagram (AB115 ETCO2 Board)**

**3.2 Low Battery Circuit.** In AB67M Mother Board Revision A with software MM02 or greater, a Low Battery Circuit is required for proper operation. Using Figure 3-4 for location information, ensure that the Low Battery Circuit is installed on AB67M Revision A boards loaded with software MM02 or greater.

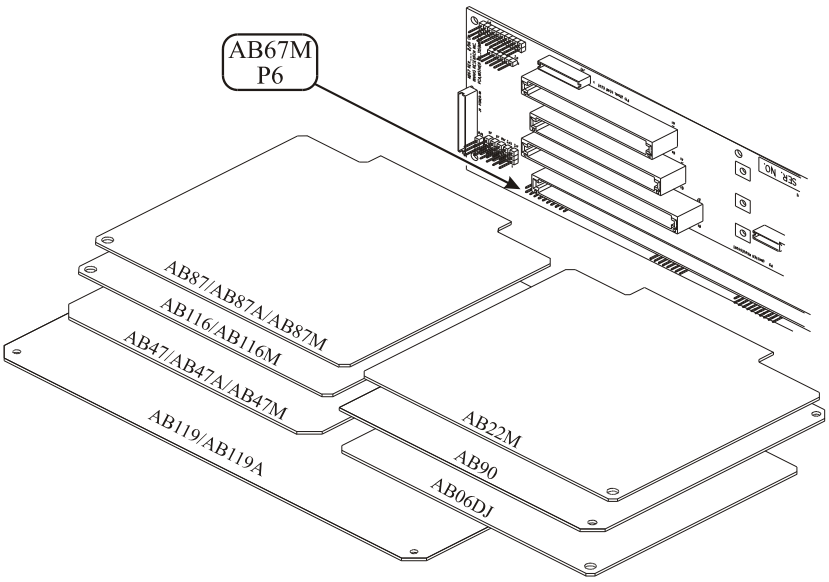



**Figure 3-4. AB67M Location Diagram**

# SECTION IV

# ADJUSTMENT PROCEDURES

## 4.0 ADJUSTMENT PROCEDURES

### CAUTION

The Model **3150/3150M Patient Monitors** contain a great number of Static Sensitive circuits. Proper handling procedures must be followed when touching any Printed Circuit Board (PCB) as static voltages usually present on clothing and personnel present great risk of damage to the circuits. **All Service Procedures MUST be performed by Properly Grounded Personnel at a Static Free Work Station**.

**4.1 Introduction.** The recommended calibration interval for the Model **3150/3150M** patient monitors is one year. Anytime repairs are made, options are installed or the monitor fails the Calibration Procedure, however, the monitor should be recalibrated.

When power to the monitor is removed, a warmup period of at least 15 minutes should elapse after power is reapplied to the unit, prior to performing any of the calibration procedures provided in this section.

Several of the test points and adjustments are only accessible by extending the assembly from the Mother Board using the appropriate Invivo Research, Inc. (IRI) Extender Board from the monitor's maintenance kit (IRI P/N 9420). When those test points are called out in the procedure, turn power OFF, disconnect AS153 power connector, disconnect battery cable P5 from the AB76 (if present), remove assy. from the mother board, connect the assy. to the appropriate extender board, then connect the extender board to the mother board. When possible attach the test equipment to the applicable test points before restoring power to the monitor.

**4.2 Setup.** Perform the following to prepare the **3150/3150M** monitor for adjustment (See Figure 4-1).

a. Ensure that the **3150/3150M** monitor Power Switch is set to the OFF position.

b. Disassemble the **3150/3150M** monitor Base and remove PCB Carriage Assembly. (See Section 3: Disassembly Procedures).

c. Disconnect battery cable P5 from the AB76/AB152 Power Board.

d. Verify the rocker-type Line Switch on the **AS153** is initially set to the OFF (○) position.

e. Connect the **AS153 AC Power Adapter** to the **3150/3150M** monitor by plugging the male DB-15 connector of power adapter cable assembly AC348 into the DC POWER jack on the **AS153**, and the remaining female DB-15 receptacle into the I/O-CHARGER PORT at the **3150/3150M** monitor base.

f. Ensure the Power Switch on the Variable Auto Transformer is initially set to the OFF position and adjust the rotary dial to the nominal line voltage (below) corresponding to the number displayed in the **AS153** voltage select window:

| Transformer Nominal AC Line Voltage | AS153 Voltage Select Switch |
|---|---|
| 220 VAC | 220 Vãc |
| 117 VAC | 120 Vãc |
| 100 VAC | 100 Vãc |

g. Plug the **AS153** AC line cord into the **AS153** power receptacle and Variable Auto Transformer power outlet.

h. Plug the Variable Auto Transformer's AC line cord into the AC wall outlet, and turn the Power Switch to the ON position.

i. Turn the **AS153** Line Switch to the ON ( **I** ) position.

j. Turn the **3150/3150M** monitor Power Switch to the ON position and allow 15 minutes for warmup.

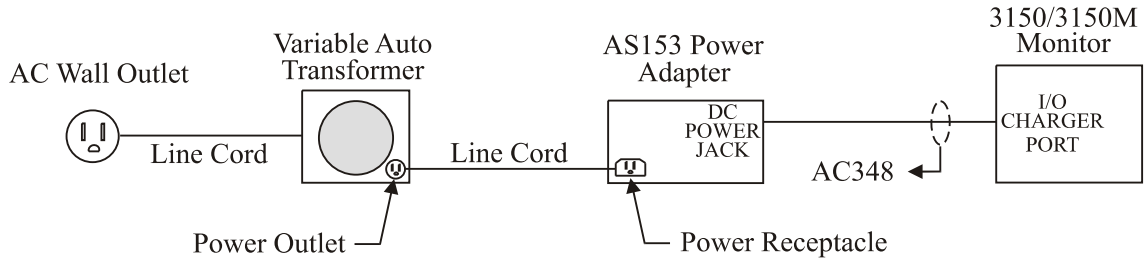



**Figure 4-1. Power Supply Test Setup**

**4.3 Power Supply Calibration (AB76 Power Board Only).** Perform the following procedure to verify proper operation of the monitor power supply.

a. **Battery Charger Reference Voltage Adjustment.** Adjust the Battery Charger Reference Voltage as follows:
   (1) Connect the DMM to the AB76 Power Board as follows:
      (a) Connect the positive (+) lead to the positive side of C1 located between R29 and R45.
      (b) Connect the negative (-) lead to P2 Pin 9 or 10 (Ground).
   (2) Adjust AB76 R6 for a reading of 13.20 Vdc (±0.05 Vdc).
   (3) Disconnect the positive (+) lead of the DMM from C1.
   (4) Using DMM, verify the following voltage points on the AB76 Power Board.
      (a) P2 Pins 1 and 2 = +13.20 Vdc (±0.25 Vdc).
      (b) P2 Pins 3 and 4 = -12.00 Vdc (±0.25 Vdc).
      (c) P2 Pins 5 and 6 = +5.05 Vdc (±0.05 Vdc).
      (d) L13 = +10.00Vdc (±0.25 Vdc).
      (e) L29 = +18.00Vdc (±2.5 Vdc).
   (5) Turn the **3150/3150M** monitor Power Switch to the OFF position.
   (6) Turn the **AS153** Line Switch to the OFF (○) position.
   (7) Disconnect the **AS153 AC Power Adapter** from the **3150/3150M** monitor by unplugging the AC348 cable from the monitor base.

b. **Low Battery Shut Off Verification.** Perform the following procedure to ensure proper shut off in a low battery condition.

(1) Connect a DC Power Supply to AB76 P5 with the Positive (+) lead on Pin 1 and the Negative (-) lead on Pin 2.
(2) Connect a DMM to the DC Power Supply and adjust the output to +16 Vdc.
(3) Turn the **3150/3150M** monitor Power Switch to the ON position.
(4) Verify proper operation of the **3150/3150M** monitor.
(5) Reduce the DC Power Supply to +11.40 Vdc (±0.5 Vdc) and verify that the message "LOW BATTERY" appears on the monitor Display Screen in approximately 30 seconds.
(6) Continue to slowly reduce the DC Power Supply to +10.80 Vdc (±0.5 Vdc) and verify that Display Screen blanks except for the message "A LOW BATTERY SHUTOFF HAS OCCURRED."
(7) Turn the **3150/3150M** monitor Power Switch to the OFF position.
(8) Disconnect the DC Power Supply from AB76 P5.
(9) Reconnect the **AS153 AC Power Adapter** to the **3150/3150M** monitor.
(10) Turn the **AS153** Line Switch to the ON ( **I** ) position.

c. **Low Line Verification.** Perform Low Line Verification as follows:
(1) Turn the **3150/3150M** monitor Power Switch to the ON position.
(2) Decrease the Variable Auto Transformer voltage setting to 102 VAC ±1.0 VAC (for 120V models), 197 VAC ±1.0 VAC (for 220V models), or 85VAC ±1.0 VAC (for 100V models).
(3) Turn ALL the Parameters ON.
(4) Verify proper operation.

d. **High Line Verification.** Perform High Line Verification as follows:
(1) Increase the Variable Auto Transformer voltage setting to 133 VAC ±1.0 VAC (for 120V models), 243 VAC ±1.0 VAC (for 220V models), or 110 VAC ±1.0 VAC (for 100V models).
(2) Verify that ALL the Parameters are ON.
(3) Verify proper operation.
(4) Return the Variable Auto Transformer to the applicable nominal line voltage setting.

e. **Battery Charge/Discharge Verification.** Perform Batter Charge/Discharge Verification as follows (See Figure 4-2):
(1) Verify +13.20 Vdc at C1 on AB76.
(2) Verify Line Switch on **AS153** and Power Switch on the **3150/3150M** monitor are in the OFF positions.
(3) Connect TF088 in series with a DC Current Meter (set for a Range of not less than 10A) to **3150/3150M** monitor AB76 P5.
(4) With DMM Ground Lead connected to the chassis of the **3150/3150M** monitor and the positive lead connected to the negative side of the current meter.
(5) Turn the **AS153** Line Switch to the ON ( **I** ) position.
(6) Verify unit charges to about +13.0 Vdc with high charge rate of 1.33A ±20%.
(7) Verify unit switches to low charge of 40mA to 120mA once the batteries have been charged to +13.0 Vdc.
(8) Turn the **AS153** Line Switch to the OFF (○) position.
(9) Disconnect the **AS153 AC Power Adapter** from the **3150/3150M** monitor by unplugging the AC348 cable from the monitor base.
(10) Turn the Power Switch on the **3150/3150M** monitor to the ON position.
(11) Verify unit powers up and current meter reads 2.3 A ±250 mA.
(12) Turn the Power Switch on the **3150/3150M** monitor to the OFF position.
(13) Disconnect TF088 and DMM leads from the unit.
(14) Reconnect the Battery Cable to AB76 P5.

(15) Reassemble the unit as required.

**List of Required Equipment**

2 Class III Meters
1 HB10A (IRI Part Number)
1 AC267 (IRI Part Number)
1 Black Banana Jack
1 Red Banana Jack
1 Set of Leads from DMM
3" WT05 (Heat Shrink)

**Assemble as follows:**

(1) Use WT05 on each solder connection.
(2) Cut connector off of HB10A wires.
(3) Cut 6" from Red Lead of HB10A and solder the wire onto the Red Lead of AC267.
(4) Attach the Red Banana Jack to the other end of the wire.
(5) Solder Black Lead from HB10A to Black Lead of AC267.
(6) Attach Black Banana Jack to the end of Red Lead from HB10A.

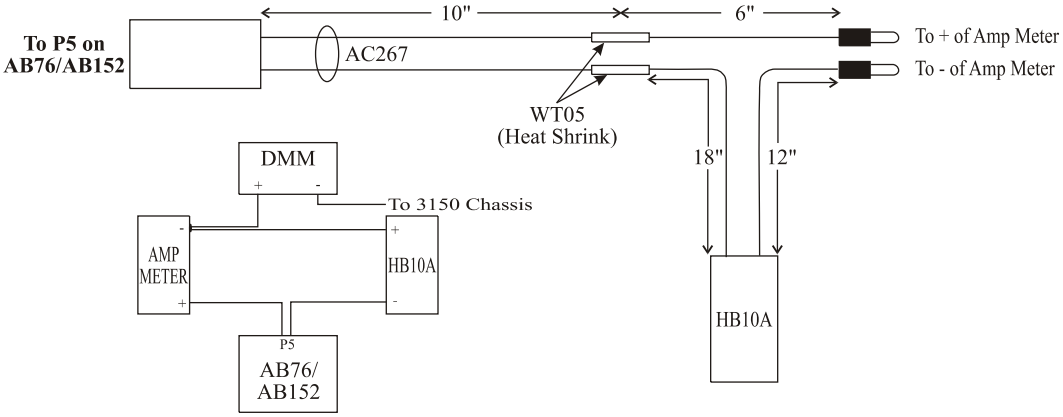



**Figure 4-2. TF0088/TF0082 Assembly Instructions**

**4.4 Power Supply Calibration (AB152 Power Board Only).** Perform the following procedure to verify proper operation of the monitor power supply.

a. **Battery Charger Reference Voltage Adjustment.** Adjust the Battery Charger Reference Voltage as follows:
   (1) Connect the DMM to the AB152 Power Board as follows:
      (a) Connect the positive (+) lead to P2 Pin 5 (Batt_Ref).
      (b) Connect the negative (-) lead to P2 Pin 9 or 10 (Ground).
   (2) Adjust AB152 R6 for a reading of 14.5 Vdc (±0.1 Vdc).
   (3) Disconnect the positive (+) lead of the DMM from P2 Pin 5.
   (4) Using DMM, verify the following voltage points on the AB152 Power Board.
      (a) P2 Pin 1 = +13.20 Vdc (±0.25 Vdc).
      (b) P2 Pin 2 = -12.00 Vdc (±0.25 Vdc).
      (c) P2 Pin 3 = +5.05 Vdc (±0.05 Vdc).
      (d) P2 Pin 6 = +10.00Vdc (±0.25 Vdc).
      (e) L29 = +18.00Vdc (±2.5 Vdc).
   (5) Turn the **3150/3150M** monitor Power Switch to the OFF position.
   (6) Turn the **AS153** Line Switch to the OFF (○) position.
   (7) Disconnect the **AS153 AC Power Adapter** from the **3150/3150M** monitor by unplugging the AC348 cable from the monitor base.

b. **Low Battery Shut Off Verification.** Perform the following procedure to ensure proper shut off in a low battery condition.
   (1) Connect a DC Power Supply to AB152 P5 with the Positive (+) lead on Pin 1 and the Negative (-) lead on Pin 2.
   (2) Connect a DMM to the DC Power Supply and adjust the output to +16 Vdc.

(3) Turn the **3150/3150M** monitor Power Switch to the ON position.
(4) Verify proper operation of the **3150/3150M** monitor.
(5) Reduce the DC Power Supply to +11.40 Vdc (±0.5 Vdc) and verify that the message "LOW BATTERY" appears on the monitor Display Screen in approximately 30 seconds.
(6) Continue to slowly reduce the DC Power Supply to +10.80 Vdc (±0.5 Vdc) and verify that Display Screen blanks except for the message "A LOW BATTERY SHUTOFF HAS OCCURRED."
(7) Continue to slowly reduce the DC Power Supply output voltage. Verify the monitor turns off at a voltage measurement of +9.9 Vdc (±0.4 Vdc)
(8) Turn the **3150/3150M** monitor Power Switch to the OFF position.
(9) Disconnect the DC Power Supply from AB152 P5.
(10) Reconnect the **AS153 AC Power Adapter** to the **3150/3150M** monitor.
(11) Turn the **AS153** Line Switch to the ON ( **I** ) position.

c. **Low Line Verification.** Perform Low Line Verification as follows:
(1) Turn the **3150/3150M** monitor Power Switch to the ON position.
(2) Decrease the Variable Auto Transformer voltage setting to 102 VAC ±1.0 VAC (for 120V models), 197 VAC ±1.0 VAC (for 220V models), or 85VAC ±1.0 VAC (for 100V models).
(3) Turn ALL the Parameters ON.
(4) Verify proper operation.

d. **High Line Verification.** Perform High Line Verification as follows:
(1) Increase the Variable Auto Transformer voltage setting to 133 VAC ±1.0 VAC (for 120V models), 243 VAC ±1.0 VAC (for 220V models), or 110 VAC ±1.0 VAC (for 100V models).
(2) Verify that ALL the Parameters are ON.
(3) Verify proper operation.
(4) Return the Variable Auto Transformer to the applicable nominal line voltage setting.

e. **Battery Charge/Discharge Verification.** Perform Batter Charge/Discharge Verification as follows (See Figure 4-2):
(1) Verify +14.5 Vdc at P2 Pin 5 on AB152.
(2) Verify Line Switch on **AS153** and Power Switch on the **3150/3150M** monitor are in the OFF positions.
(3) Connect TF082 in series with a DC Current Meter (set for a Range of not less than 10A) to **3150/3150M** monitor AB152 P5.
(4) With DMM Ground Lead connected to the chassis of the **3150/3150M** monitor and the positive lead connected to the negative side of the current meter.
(5) Turn the **AS153** Line Switch to the ON ( **I** ) position.
(6) Verify unit charges to within a range of +13.0 Vdc to +14.5 Vdc with high charge rate of 1.33A ±20%.
(7) Verify unit switches to low charge of 20mA to 100mA once the batteries have been charged to +14.5 Vdc.
(8) Turn the **AS153** Line Switch to the OFF (○) position.
(9) Disconnect the **AS153 AC Power Adapter** from the **3150/3150M** monitor by unplugging the AC348 cable from the monitor base.
(10) Turn the Power Switch on the **3150/3150M** monitor to the ON position.
(11) Verify unit powers up and current meter reads 2.3 A ±250 mA.
(12) Repeat steps 5 through 11 above for the remaining battery cables.

**NOTE**
The batteries may need to be slightly discharged before each test.

(13) Turn the Power Switch on the **3150/3150M** monitor to the OFF position.
(14) Disconnect TF082 and DMM leads from the unit.
(15) Reconnect the Battery Cable to AB152 P5.
(16) Reassemble the unit as required.

**4.5 LCD Module Intensity Adjustment.** Adjust the intensity of the LCD display as follows:

a. Turn the **3150/3150M** monitor Power Switch to the ON position.

b. With an insulated flat head tuning tool, adjust AB75 R4 (accessible through the rear display panel), for display brightness.

c. Turn the **3150/3150M** monitor Power Switch to the OFF position.

d. Remove the Display Assembly from the column.

e. Turn the **3150/3150M** monitor Power Switch to the ON position.

f. Adjust AB98B RV (located at the bottom center of the AB98B LCD Module) for the clearest, sharpest display when viewed from all angles.

g. Turn the **3150/3150M** monitor Power Switch to the OFF position.

h. Reassemble the Display Assembly in the column.

**4.6 Speaker Volume Adjustment (Model 3150M Monitor Only).** Adjust the speaker pulse tone volume on the **Magnitude™ 3150M** monitor as follows:

a. Verify the sound volume is audible and free of distortion.

b. Press the **ALARM** control key to silence the alarm.

c. Verify the alarm light goes off.

d. Press and hold the **ALARM** control key until the software revision menu appears on the LCD display.

e. Adjust pulse tone volume up or down by pressing the **ECG SIZE** or **ECG LEAD** control keys, respectively.

**4.7 Signal Processor Reference Voltage Adjustment.** Adjust the Signal Processor Reference Voltage as follows:

a. Connect the DMM to the AB87/AB87A/AB87M ECG Analog Board as follows:
(1) Connect the positive (+) lead to the 5.12V Test Point (located above P1).
(2) Connect the negative (-) lead to TP1 (Ground).

b. Turn the **3150/3150M** monitor Power Switch to the ON position.

c. Adjust AB47/AB47A/AB47M R16 to 5.124 Vdc (±0.005 Vdc). This adjustment is accessible from the side of the card cage.

d. Disconnect the DMM from the ECG Analog Board.

**4.8 NIBP Adjustments.** There are several adjustments possible on the AB06DJ NIBP Board. After any repair, service or any time monitor inaccuracy is suspected, the following adjustment procedure should be performed by a Qualified Service Representative. Adjust the AB06DJ NIBP Board as follows:

a. **Setup.** Perform the following setup procedure to prepare the AB06DJ NIBP Board for adjustment:
   (1) Turn the **3150/3150M** monitor Power Switch to the OFF position.
   (2) Disconnect the **AS153 AC Power Adapter** and Battery Cable P5 from the AB76 Board.
   (3) Remove the AB06DJ NIBP Board from the Mother Board.
   (4) Connect the AB06DJ NIBP Board to the extender board.
   (5) Connect the extender board to the Mother Board.

b. **Reference Voltage Adjustment.** Adjust the NIBP Reference Voltage as follows:
   (1) Turn the **3150/3150M** monitor Power Switch to the ON position.
   (2) Connect the DMM to the AB06DJ NIBP Board as follows:
      (a) Connect the DMM positive (+) lead to U5 Pin 1.
      (b) Connect the DMM negative (-) lead to the anode of CR20.
   (3) Adjust the reference voltage potentiometer R44 for a reading of 4.995 Vdc (±0.005 Vdc).
   (4) Bring up the NIBP Diagnostics Screen by pressing and holding the **ALARM** Control Key for approximately three (3) seconds.

**NOTE**

The diagnostics mode is limited to 3.5 minutes. At that time the NIBP Diagnostics and System Voltages will return to "0".

   (5) Disconnect the input power cable (red and black wires) from the HE60 Transceiver located in the column behind the service panel.
   (6) If in the NEO Mode, press the **NIBP ADULT/NEO** Control Key to select ADULT.
   (7) Adjust AB06DJ R43 for DC = 6 (±1) on the NIBP Diagnostics Screen.
   (8) Adjust AB06DJ R41 for AC = 80 (±1) on the NIBP Diagnostics Screen.
   (9) Press the **NIBP ADULT/NEO** Control key to select NEO.
   (10) Adjust AB06DJ R6 for AC = 80 (±2) on the NIBP Diagnostics Screen.
   (11) Connect Pressure Tester (Deadweight or Manometer) to the NIBP Sense Port (located on the Parameter Input Panel, NIBP Left Port).
   (12) Set the Pressure Tester for 200 mmHg pressure.
   (13) Adjust AB06DJ R42 for DC = 206 (±1) on the NIBP Diagnostics Screen.
   (14) Disconnect the Pressure Tester.
   (15) Press the **NIBP ADULT/NEO** Control Key to select ADULT.

c. **Adult Gain and Bandwidth Verification.** Perform Adult Gain and Bandwidth Verification as follows (See Figure 4-3):
   (1) Turn the **3150/3150M** monitor Power Switch to the OFF position.

(2) Follow the AB06DJ Transducer Input Cable, (red, green and black wires) down to the base and disconnect the 3 pin stix connector from Transducer Column Input Cable.
(3) Connect a Signal Generator to the AB06DJ Transducer Input Cable Green Wire using the Black Wire as the Ground.
(4) Connect a 49.9KΩ resistor from the junction of AB06DJ R24-R25 (or U2 Pin 3) to the Red Wire.
(5) Set the Signal Generator output for a sine wave of 2.5 Hz, 12.5mV$_{pp}$ with no DC Offset.
(6) Set Oscilloscope Channel 1 to 50mV/Div (AC Coupled), Time Base to 0.5msec/Div, and Trigger to Normal Mode.
(7) Connect a X10 Scope Probe to AB06DJ TPAC using the anode of CR20 as Ground.
(8) Turn the **3150/3150M** monitor Power Switch to the ON position.
(9) On the Oscilloscope, verify a 2.5 Hz, 2.2V$_{pp}$ (±0.44V) waveform.
(10) Decrease the frequency of the Signal Generator until the amplitude, as observed on the Oscilloscope, is exactly ½ of what it was at 2.5 Hz.
(11) Verify that the frequency is at 0.5 Hz (±0.1 Hz).
(12) Return the Signal Generator to 2.5 Hz.
(13) On the Oscilloscope, verify a 2.2V$_{pp}$ (±0.44V) waveform.
(14) Increase the frequency of the Signal Generator until the amplitude, as observed on the Oscilloscope, is exactly ½ of what it was at 2.5 Hz.
(15) Verify that the frequency is at 8 Hz (±1 Hz).

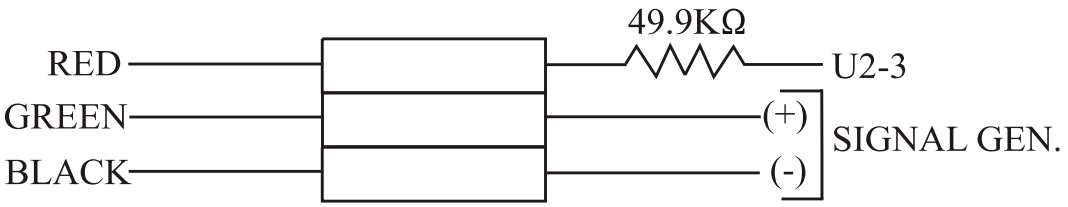



**Figure 4-3. AB06DJ Transducer Input Cable**

d. **NEO Gain and Bandwidth Verification.** Perform NEO Gain and Bandwidth Verification as follows:
(1) Set the Signal Generator to 2.5Hz, 3mV$_{pp}$ with no DC Offset.
(2) Move the X10 Oscilloscope Probe to AB06DJ TP NEO.
(3) On the Oscilloscope, verify a 2.2V$_{pp}$ (±0.44V) waveform.
(4) Decrease the frequency of the Signal Generator until the amplitude, as observed on the Oscilloscope, is exactly ½ of what it was at 2.5 Hz.
(5) Verify that the frequency is at 0.5 Hz (±0.1 Hz).
(6) Return the Signal Generator to 2.5 Hz.
(7) On the Oscilloscope, verify a 2.2V$_{pp}$ (±0.44V) waveform.
(8) Increase the frequency of the Signal Generator until the amplitude, as observed on the Oscilloscope, is exactly ½ of what it was at 2.5 Hz.
(9) Verify that the frequency is at 8 Hz (±1 Hz).
(10) Turn the **3150/3150M** monitor Power Switch to the OFF position.
(11) Disconnect the Signal Generator.
(12) Disconnect the 49.9KΩ resistor.
(13) Reconnect the AB06DJ Transducer Input Cable (red, green and black wires) to the Transducer Column Input Cable observing proper connection by matching wire colors.

**CAUTION**

Improper connection will result in severe damage to the NIBP Transducer Board.

e. **Transducer Noise Verification.** Perform Transducer Noise Verification as follows:
   (1) Connect the X10 Oscilloscope Probe to TP NEO on the AB06DJ Board using the anode of CR20 as Ground. These test points are both accessible through the side of the card cage.
   (2) Set the Oscilloscope Channel 1 to 50mV/Div (AC Coupled), Time Base to 0.5 sec/Div, and Trigger to Auto Mode.
   (3) Turn the **3150/3150M** monitor Power Switch to the ON position.
   (4) Verify the Low Frequency ("popcorn") Transducer Noise is less than $150mV_{pp}$.
   (5) Disconnect the Oscilloscope from the AB06DJ Board.

**NOTE**

The Fail Safe Timeout Verification Test requires the use of a stopwatch.

f. **Fail Safe Timeout Verification.** Perform Fail Safe Timeout Verification as follows:
   (1) Connect a manometer to the sense port at the front of the **3150/3150M** monitor.
   (2) Close the hand bulb and pump the bulb until the manometer reaches 250 mmHg.
   (3) Connect a jumper across AB06DJ CR20 (near U4) on the component side of the board and start the stop watch.
   (4) Verify that the message "TIME-OUT" is displayed on the lower left of the **3150/3150M** monitor Display Screen after 180 seconds (±30 seconds).
   (5) Connect the X10 Oscilloscope probe to AB06DJ U4 Pin 3 using CR20 as Ground.
   (6) Verify that AB06DJ U4 Pin 3 is High (+5 Vdc).
   (7) Turn the **3150/3150M** monitor Power Switch to the OFF position.
   (8) Disconnect the manometer and Oscilloscope test probe.
   (9) Disconnect the jumper from the AB06DJ NIBP Board.

g. **NIBP Overpressure Switch Adjustment.** Adjust the NIBP Overpressure Switch as follows:
   (1) Turn the **3150/3150M** monitor Power Switch to the ON position.
   (2) Connect a manometer to the NIBP Inflate Port (located on the Parameter Input Panel - NIBP right port).
   (3) If necessary, press the **NIBP ADULT/NEO** Control Key to select Adult.
   (4) Press the **NIBP START/STOP** Control key to start the pump.
   (5) Slowly close the bleed screw on the manometer hand bulb at a rate of 50 mmHg per second until the manometer reaches 265 mmHg (±5 mmHg).
   (6) Verify that the pump shuts itself OFF when the above limits are violated and that the message "OVR-PRES" is displayed on the **3150/3150M** monitor Display Screen.
   (7) To adjust, insert a small shaft 0.05mm hex driver into the overpressure switch located on the side of the Pneumatic Assembly and turn it until the above specification is achieved.
   (8) Turn the **3150/3150M** monitor Power Switch to the OFF position.
   (9) Disconnect the manometer from the NIBP Inflate Port.
   (10) Reassemble as necessary.
   (11) Reconnect the input power cable (red and black wires) to the HE60 Transceiver located in the column behind the service panel.

h. Perform NIBP Verification Procedure (**See Section 2**).

**4.9 ECG Amplifier Adjustments.** Perform ECG Amplifier Adjustments as follows.

a. **Setup.** Perform the following setup procedure to prepare the AB86 and AB89 Boards for adjustment:
   (1) Turn the **3150/3150M** monitor Power Switch to the OFF position.
   (2) Remove the AS149 Isolation Board Assembly from the column (**See Section 3**).
   (3) Turn the AS149 Isolation Board Assembly so the AB86 and AB89 boards are facing outward.
   (4) Reconnect all cables.
   (5) Turn the **3150/3150M** monitor Power Switch to the ON position.
   (6) Connect the ECG Patient Simulator to the ECG Input on the Parameter Input Panel.
   (7) Setup the ECG Patient Simulator to output a 1 mV square wave at 2 Hz.
   (8) Set the **3150/3150M** monitor to **LEAD II** with **SIZE** set to 10.
   (9) Turn the **Millennia® 3155MVS/3155A** monitor Power Switch to the ON position.

b. **Initial Voltage Adjustment.** Perform the Initial Voltage Adjustment as follows:
   (1) Connect the DMM as follows:
      (a) Connect the positive (+) lead to AB86 TP9.
      (b) Connect the negative (-) Lead to AB86 TP10 (ISOGND2).
   (2) Adjust AB87 R15 for the maximum positive voltage on DMM.
   (3) Verify voltage is greater than +10.50 Vdc.
   (4) Disconnect the DMM.

c. **ECG Drive Adjustments.** Perform ECG Drive Adjustments as follows:
   (1) Connect the DMM as follows:
      (a) Connect the positive (+) lead to AB86 TP1.
      (b) Connect the negative (-) Lead to AB86 TP2.
   (2) Adjust AB86 R90 for +3.06 Vdc ±0.06 Vdc.
   (3) Disconnect the DMM.
   (4) Connect the DMM as follows:
      (a) Connect the positive (+) lead to AB86 TP5.
      (b) Connect the negative (-) lead to AB86 TP6.
   (5) Adjust AB86 R100 for 3.06 Vdc ±0.06 Vdc.
   (6) Disconnect the DMM.

d. **ECG Offset Adjustments.** Perform ECG Offset Adjustments as follows:
   (1) Connect the DMM as follows:
      (a) Connect the positive (+) lead to AB86 TP3.
      (b) Connect the negative (-) lead to AB86 TP7.
   (2) Adjust AB86 R91 for +0.00Vdc ±0.01Vdc.
   (3) Disconnect the DMM positive (+) lead from AB86 TP3.
   (4) Connect the DMM positive (+) lead to AB86 TP4.
   (5) Adjust AB86 R101 for +0.00 Vdc ±0.01 Vdc.
   (6) Disconnect the DMM.

e. **ECG Recorder Gain Adjustment.** Perform ECG Recorder Gain Adjustment as follows:
   (1) Press the **RECORD** Control Key on the **Millennia® 3155MVS/3155A** monitor Front Panel Key Pad.
   (2) Adjust **3150/3150M** monitor AB87/AB87A/AB87M R109 for a 10 mm (2 division) deflection on the recorder strip.
   (3) Verify an ECG rate of 240 BPM.

f. **ECG Cal Gain Adjustment.** Perform ECG Cal Gain Adjustment as follows:
   (1) Select the Calibration Mode on the **Millennia® 3155MVS/3155A** monitor as follows:
      (a) Turn the Rotary Knob to highlight the **ECG** Icon.
      (b) Press the Rotary Knob to select the **ECG** Menu.
      (c) Turn the Rotary Knob to highlight the **CAL** menu selection.
      (d) Press and hold the Rotary Knob until the ECG CAL signal has stabilized.
      (e) Release the Rotary Knob.
   (2) Press the **RECORD** Control Key.
   (3) Adjust AB87/AB87A/AB87M R102 for a 10 mm (2 division) deflection on the recorder strip.

g. Reassemble the monitor as necessary.

h. Perform ECG Verification (**See Section 2**).

**4.10 Invasive Pressure Adjustments.** Perform Invasive Pressure Adjustments as follows.

**NOTE**

Perform the following steps only for units that have the P1 and P2 option (AB90 Non-Iso Board) installed.

a. **Setup.** Perform the following to prepare the Invasive Pressure section for adjustment.
   (1) Turn the **3150/3150M** monitor Power Switch to the OFF position.
   (2) Disconnect the **AS153 AC Power Adapter** and battery cable from the AB76.
   (3) Remove the AB90 Invasive Pressure Non-Iso Board from the Mother Board.
   (4) Connect the AB90 Board to an extender board.
   (5) Plug the extender board into the Mother Board.
   (6) Turn the **3150/3150M** monitor Power Switch to the ON position.

b. **Initial Voltage Adjustment.** Perform the Initial Voltage Adjustment as follows:
   (1) Connect the DMM as follows:
      (a) Connect the positive (+) lead to AB89 BOX 1 Pin 2 (top pin).
      (b) Connect the negative (-) lead to AB89 BOX 1 Pin 10 (bottom pin).
   (2) Adjust AB90 R33 for +8.0 Vdc ±0.5 Vdc.
   (3) Disconnect the DMM.
   (4) Turn the **3150/3150M** monitor Power Switch to the OFF position.
   (5) Disconnect the **AS153 AC Power Adapter** and battery cable P5 from the AB76.
   (6) Disconnect the extender board from the Mother Board.
   (7) Disconnect the AB90 Invasive Pressure Non-Iso Board from the extender board.
   (8) Connect the AB90 Invasive Pressure Non-Iso Board to the Mother Board.
   (9) Turn the **3150/3150M** monitor Power Switch to the ON position.

c. **Pressure Excitation Voltage Adjustment.** Perform Pressure Excitation Voltage Adjustment as follows:
   (1) Connect the DMM as follows:
      (a) Connect the positive (+) lead to Invasive Pressure Connector P1-B insert.
      (b) Connect the negative (-) lead to Invasive Pressure Connector P1-D insert.
   (2) Adjust AB89 R22 for 1.536 Vdc ±0.01 Vdc.
   (3) Disconnect the DMM.
   (4) Connect the DMM as follows:
      (a) Connect the positive (+) lead to Invasive Pressure Connector P2-B insert.
      (b) Connect the negative (-) lead to Invasive Pressure Connector P2-D insert.

(5) Verify a measurement of 1.536 Vdc ±0.01 Vdc.

d. **P1 Reference Zero and Gain Adjustments.** Perform P1 Reference Zero and Gain Adjustments as follows:
(1) Connect the output of a Fogg BP-600 (or equivalent) Pressure Simulator to the P1 input on the Parameter Input Panel of the **3150/3150M** monitor.
(2) Set the Pressure Simulator to 0 mmHg.
(3) Connect the DMM as follows:
(a) Connect the positive (+) lead to AB89 TP6.
(b) Connect the negative (-) lead to AB89 TP7.
(4) Adjust AB89 R36 for 3.06 Vdc ±0.06 Vdc.
(5) Disconnect the DMM.
(6) Connect the DMM as follows:
(a) Connect the positive (+) lead to AB89 TP3.
(b) Connect the negative (-) Lead to the chassis (Ground).
(7) Adjust AB89 R37 for 0.000 Vdc ±0.050 Vdc.
(8) Disconnect the DMM.
(9) Press the **PRESSURE P1 ZERO/ON** Control Key.
(10) Verify the following:
(a) The message "P-CAL: DONE" is displayed on the Display Screen.
(b) The P1 numeric display indicates 0 mmHg ±1 mmHg.
(11) Set Pressure Simulator to 240 mmHg ±1 mmHg.
(12) Adjust AB89 R27 for a P1 numeric display indication of 240 mmHg ±1 mmHg.
(13) Set Pressure Simulator to 0 mmHg.
(14) Verify a P1 numeric display indication of 0 mmHg ±1 mmHg.
(15) Repeat adjustments as required.
(16) Disconnect Pressure Simulator.

e. **P2 Reference Zero and Gain Adjustments.** Perform P2 Reference Zero and Gain Adjustments as follows:
(1) Connect the output of a Fogg BP-600 (or equivalent) Pressure Simulator to the P2 input on the Parameter Input Panel of the **3150/3150M** monitor.
(2) Set the Pressure Simulator to 0 mmHg.
(3) Connect the DMM as follows:
(a) Connect the positive (+) lead to AB89 TP8.
(b) Connect the negative (-) lead to AB89 TP9.
(4) Adjust AB89 R50 for 3.06 Vdc ±0.06 Vdc.
(5) Disconnect the DMM.
(6) Connect the DMM as follows:
(a) Connect the positive (+) lead to AB89 TP4.
(b) Connect the negative (-) lead to the chassis (Ground).
(7) Adjust AB89 R51 for 0.000 Vdc ±0.050 Vdc.
(8) Disconnect the DMM.
(9) Press the **PRESSURE P2 ZERO/ON** Control Key.
(10) Verify the following:
(a) The message "P-CAL: DONE" is displayed on the Display Screen.
(b) The P2 numeric display indicates 0 mmHg ±1 mmHg.
(11) Set Pressure Simulator to 240 mmHg ±1 mmHg.
(12) Adjust AB89 R41 for a P2 numeric display indication of 240 mmHg ±1 mmHg.
(13) Set Pressure Simulator to 0 mmHg.
(14) Verify a P2 numeric display indication of 0 mmHg ±1 mmHg.
(15) Repeat adjustments as required.
(16) Disconnect Pressure Simulator.

f. Reassemble the AS149 Isolation Board Assembly to the column.

g. Perform Invasive Pressure Verification (**See Section 2**).

**4.11 ETCO2 Adjustment.** Perform ETCO2 Adjustment as follows:

**NOTE**

Perform the following steps only for units that have the ETCO2 option (AS159 module) installed.

a. **Setup.** Prepare for adjustment of the ETCO2 as follows:
   (1) Turn the **3150/3150M** monitor Power Switch to the OFF position.
   (2) Remove AS159 ETCO2 Module from the base and place it outside the unit on a non-conductive surface.
   (3) Disconnect the input power cable (red and black wires) from the HE60 Transceiver located in the column behind the service panel.
   (4) Connect manometer to ETCO2 patient port on column.
   (5) Pinch off tubing between SENSE IN on AP45A and the sensor on the AS159 module.
   (6) Apply 280 mmHG and verify no more than 4 mmHg drop in pressure within 60 seconds.
   (7) Obtain the current barometric pressure reading (inches of Hg.) and perform the following calculation: Barometric Pressure (Hg) X 25.4 mm/in. X 0.005V/mmHg. (The value should be approximately 3.800Vdc.)
   (8) Disconnect pump from AB115 J2.

b. **Barometric Adjustment.** Perform Barometric Adjustment as follows:
   (1) Turn the **3150/3150M** monitor Power Switch to the ON position.
   (2) Turn ETCO2 ON and allow 15 minutes for warmup.
   (3) Connect the DMM as follows:
      (a) Connect the positive (+) lead to U3 Pin 6.
      (b) Connect the negative (-) lead to R34 leg near the board edge.
   (4) Adjust RP1 for the above calculated value.
   (5) Disconnect the DMM positive (+) lead.
   (6) Connect the DMM positive (+) lead to U2 Pin 6.
   (7) Adjust RP4 for 1.000 Vdc ± 10 mVdc.
   (8) Disconnect the DMM positive (+) lead.
   (9) Carefully remove the tubing from the U6 Transducer Port (near C10).
   (10) Use a manometer and proper size tubing to apply 100 mmHg to the U6 Transducer Port.
   (11) Connect the DMM positive (+) lead to U2 Pin 6.
   (12) Adjust RP5 for 2.000 Vdc ±10 mVdc.
   (13) Recheck DMM reading with and without pressure to U6 while adjusting RP4 and RP5 as necessary.
   (14) Turn the **3150/3150M** monitor Power Switch to the OFF position.
   (15) Reconnect tubing to the U6 Transducer Port.
   (16) Reconnect pump to AB115 J2.

c. **High and Low Flow Adjustments.** Perform High and Low Flow Adjustments as follows:
   (1) Turn the **3150/3150M** monitor Power Switch to the ON position.
   (2) Press the **NIBP ADULT/NEO** Control Key to select NEO (this selects Low Flow).
   (3) Connect Flow Meter to the ETCO2 Port on the Parameter Input Panel.

(4) Adjust RP2 for a reading of 150 ml ±5 ml.
(5) Press the **NIBP ADULT/NEO** Control Key to select ADULT (this selects High Flow).
(6) Adjust RP6 for a reading of 230 ml ±5 ml.
(7) Turn the **3150/3150M** monitor Power Switch to the OFF position.
(8) Reassemble unit and reconnect cables as necessary.

d. Perform ETCO2 Verification (**See Section 2**).

**4.12 Gating Adjustment.** Perform the Gating Adjustment Procedure as follows:

a. Connect the DMM as follows:
(1) Connect the DMM positive (+) lead to R10 (side closest to C32).
(2) Connect the DMM negative (-) lead to D9 (lead towards center of board).

b. Adjust R12 for 5.12 Vdc ±0.01 Vdc.

c. Ensure jumper is set between pin 1 and 2 at location JMP 1.

d. Perform Gating Verification (**See Section 2**).

# SECTION V

# HE60 RADIO TRANSCEIVER PROGRAMMING INSTRUCTIONS

## 5.0 PROGRAMMING INSTRUCTIONS

**5.1 Introduction.** The WIT2400 (Invivo P/N HE60) radio transceivers can be programmed and/or reprogrammed to accommodate various communications setup configurations for the **Millennia® 3155MVS/3155A** monitors**,** Model **3150/3150M** monitors**,** and **AS163 Siemens Transceiver Modules.** This section provides setup information and specific instructions to program the radio transceivers for operation in the various system configurations.

The WIT2410 (Invivo P/N AB182B) radio transceivers are new radios required with dual 3155 communications setup configurations and on **3155MVS** or **3155A** monitors communicating with **3150** or **3150M** communications setup configurations, but cannot be used in communications setup configurations for the **Millennia® 3155MVS/3155A** monitors, Model **3150/3150M** monitors, and **AS163 Siemens Transceiver Modules**.

**5.2 Required Test Equipment.** The following test equipment is required to program the HE60 or AB182B radio transceivers installed in the **3150/3150M** monitors:

- TF0078 Test Fixture
- Two 9 Vdc batteries
- WIT2400 (Invivo P/N HE60) or WIT2410 (Invivo P/N AB182B) radio transceiver
- IBM-compatible pc with Windows 95/98/2000 installed
- Cirronet *WinCom24* (Version 1.1) communications software application installed in default *C:\wincom24* folder on pc

**5.3 Setup.** Perform the following steps to prepare the **3150/3150M** monitor HE60 or AB182B radio transceivers for receiving programming instructions:

a. Plug the test fixture's DB25 connector into an unused pc serial COM port (use a DB25-pin to DB9-pin adapter if required).

b. Attach a fully charged 9 Vdc battery to the pigtailed battery cable (red and black wires) located on the pc side of the test fixture's DB25 cable.

c. Plug the 13-pin side of the test fixture's DB25 cable into the mating jack on the HE60 or AB182B transceiver.

d. Attach a fully charged 9 Vdc battery to the separately supplied pigtailed battery cable (red and black wires), but do **not** plug the other end of the battery cable into the mating transceiver jack.

**NOTE**

The HE61 RF antenna should be disconnected from the HE60 or AB182B transceiver while performing the radio programming procedures in this section.

e. Initialize the *WinCom24* application software in Windows.

f. Verify or select the following setup parameters:
   - BaudRate - 9600 bps if new radio (9600, 19200, or 57600 for reprogram).
   - ComPort - Set to match spare COM port attached to test fixture in step "a" above.

g. Plug the free end of the separate pigtailed battery cable into the mating jack on the HE60 or AB182B transceiver (with 9 Vdc battery attached).

h. The following message is displayed on the screen:

WIT2400 v3.40 Digital Wireless © 1996
:Base [or] :Remote*

**NOTE**

*If the HE60 radio transceiver was originally programmed as a base transceiver, ":Base" will be displayed in the above step. Similarly, ":Remote" will appear if the transceiver was preprogrammed at the factory as a remote unit.

i. Type **:wit2400**.

j. A data entry prompt (">") is displayed on the screen to indicate the HE60 transceiver has entered the programming mode.

k. Proceed to paragraph 5.4, 5.5, or 5.6 depending on how it is desired to program the HE60 radio transceivers for your system.

**5.4 HE60 Programming for Single 3155 Communications.** Perform the following steps to program the **3150** series monitor for remote radio communications with a single **3155** series monitor.

**NOTE**

Confirm that proms AM59(X)A and AM59(X)B are installed in sockets U19 and U18 of the AB119 Master Processor board respectively, before performing the following procedure. This can be verified without disassembling the unit by pressing and holding the ALARM SILENCE control key on the Model 3150 monitor for approximately 3 seconds and noting that the value displayed for the master processor begins with a prefix of "MM" (i.e., MASTER=MM*XX*).

**NOTE**

These programming instructions may not be fully backwards-compatible with the original factory programming supplied with older 3150/3155 series models if **only one** of the associated radio transceivers is reprogrammed by the technician. If your 3150 series monitor bears any of the following serial numbers (SNs), you must ensure that the HE60 transceivers located in **both** the 3150 series and the 3155 series patient monitors are reprogrammed in accordance with this procedure.

(3150 SNs: 100-117, 119-189, 195, 197)

a. Enter radio parameter data into the HE60 transceiver's memory by performing the following steps. Each radio parameter is entered by typing a two-letter code and then the applicable value associated with that code. (For example, the two-letter code to set the radio's address, or ID code, is "ws." To specify a radio address value of AA, the programmer should then type: **wsAA** <Enter>.)

b. When the programmer types a radio parameter and presses <Enter>, the radio will automatically echo the value just entered on the next line on the computer screen. (To continue the above example, if the programmer types **wsAA** <Enter>, the next line on the screen will display the following text: AA.)

c. Enter all required *NETWORK COMMANDS* as follows:

| Command | 3155 Series (BASE) | 3150 Series (REMOTE) | DESCRIPTION |
|---|---|---|---|
| wn | ____ | ____ | Set Network Number (0 thru f) |
| wb | 1 | 0 | Set Base=1/ Remote=0 |
| wd | AA | n/a | Set Destination Address (never use ff) |
| ws | n/a | AA | Set Source Address (never use ff) |
| wt | 0 | 0 | Set Channel Access Mode (0=CSMA/1=TDMA) |
| wp | 1 | 1 | Set Transmit Power (0=low power/1=hi power) |

d. Enter all required *SERIAL INTERFACE COMMANDS* as follows:

| Command | 3155 Series (BASE) | 3150 Series (REMOTE) | DESCRIPTION |
|---|---|---|---|
| sy | 0 | 0 | Set 0=Asynchronous/1=Synchronous |
| sd | 083 | 083 | Set Data Rate (083=9600 bps) |
| sp | 0 | 0 | Set Packet Mode (0=point-to-point/1=multipt) |

e. Enter all required *PROTOCOL COMMANDS* as follows:

| Command | 3155 Series (BASE) | 3150 Series (REMOTE) | DESCRIPTION |
|---|---|---|---|
| ph | $28_{16}$ | $28_{16}$ | Set Hop Duration ($28_{16}$=6.144 msec) |
| pk | n/a | 01 | Set Minimum Packet Length |
| pl | n/a | $40_{16}$ | Set Maximum Packet Length |
| pt | n/a | 03 | Set Packet Timeout Duration |
| pm | n/a | 10 | Set Link Margin |
| pr | 08 | 08 | Set ARQ Attempt Limit |
| py | n/a | 02 | Set ARQ Per-Hop Limit |
| pb | n/a | 01 | Set CSMA Backoff Constant |
| pp | n/a | ff | Set CSMA Persistence |
| ps | n/a | 0A | Set TDMA Time Slot |
| pg | 0 | 0 | Enable Peer Addressing (0=disable/1=enable) |
| px | 0 | 0 | Enable Redundant Transmit (0=disable/1=enable) |
| pe (see note) | 0 | 0 | Enable Limited ETSI Channel Set (0=disable/1=enable) |
| pd | 0 | 0 | Antenna Diversity (0=disable/1=enable) |

**NOTE**

When programming radios for France, “pe” must be set to 1 for a limited radio frequency range of from 2448 to 2480.

f. Enter all required *STATUS COMMANDS* as follows:

| Command | 3155 Series (BASE) | 3150 Series (REMOTE) | DESCRIPTION |
|---|---|---|---|
| zb | 1 | 1 | Banner Display (0=disable/1=enable) |
| zc | 1 | 1 | Escape Sequence (0=disable/1=enable) |
| zp | 0 | 0 | Power Save Mode (0=disable/1=enable) |

g. When all parameter data is entered into the HE60 radio transceiver's memory, type **m>** <Enter> to save the encoded parameters.

h. Exit the programming mode by typing: **z>** <Enter>.

i. Unplug the 9 Vdc batteries from both pigtailed battery cables (red and black wires).

j. Unplug the test fixture from the pc and HE60 transceiver. Store test fixture with batteries for future use.

**5.5 HE60 Programming for 3155/AS163 Communications.** Perform the following steps to program the **3150** series monitor for radio communications with a remote **3155** series monitor and a remote **Siemens AS163** transceiver module.

**NOTE**

Confirm that proms AM67A and AM67B are installed in sockets U19 and U18 of the AB119A Master Processor board respectively, before performing the following procedure. This can be verified without disassembling the unit by pressing and holding the ALARM SILENCE control key on the Model 3150 monitor for approximately 3 seconds and noting that the value displayed for the master processor begins with a prefix of "MU" (i.e., MASTER=MU*XX*).

a. Enter radio parameter data into the HE60 transceiver's memory by performing the following steps. Each radio parameter is entered by typing a two-letter code and then the applicable value associated with that code. (For example, the two-letter code to set the radio's address, or ID code, is "ws." To specify a radio address value of AA, the programmer should then type: **wsAA** <Enter>.)

b. When the programmer types a radio parameter and presses <Enter>, the radio will automatically echo the value just entered on the next line on the computer screen. (To continue the above example, if the programmer types **wsAA** <Enter>, the next line on the screen will display the following text: AA.)

c. Enter all required *NETWORK COMMANDS* as follows:

| Command | 3150 Series (BASE) | 3155 Series (REMOTE) | AS163 (REMOTE) | DESCRIPTION |
|---|---|---|---|---|
| wn | ____ | ____ | ____ | Set Network Number (0 thru f) |
| wb | 1 | 0 | 0 | Set Base=1/ Remote=0 |
| wd | 44 | AA | AA | Set Destination Address (never use ff) |
| ws | 88 | AA | 55 | Set Source Address (never use ff) |
| wt | 1 | 1 | 1 | Set Channel Access Mode (0=CSMA/1=TDMA) |
| wp | 1 | 1 | 1 | Set Transmit Power (0=low power/1=hi power) |

d. Enter all required *SERIAL INTERFACE COMMANDS* as follows:

| Command | 3150 Series (BASE) | 3155 Series (REMOTE) | AS163 (REMOTE) | DESCRIPTION |
|---|---|---|---|---|
| sy | 0 | 0 | 0 | Set 0=Asynchronous/ 1=Synchronous |
| sd (see note) | 014 | 083 | 083 | Set Data Rate (083=9600 bps), (014=57600 bps) |
| sp | 1 | 0 | 0 | Set Packet Mode (0=point-to-point/1=multipt) |

**NOTE**

After a radio's communication data rate has been changed (Set Data Rate code "sd" above), the radio will then expect all further communication to proceed at the new data rate. Therefore, the programmer must alter the "BaudRate" value in *WinCom24* to correspond with the new rate programmed into the radio (Remote 083=9600bps; Base 014=57600bps). When, and ONLY when, the data rate programmed into the radio transceiver has been changed, change the "BaudRate" value in *WinCom24* to match the new data rate just programmed into the radio transceiver (do **NOT** disconnect the test fixture from the pc or HE60 transceiver). Type the query: **sd?** <Enter>, and verify that the screen echoes the new data rate programmed into the radio transceiver on the next line on the screen.

e. Enter all required *PROTOCOL COMMANDS* as follows:

| Command | 3150Series (BASE) | 3155 Series (REMOTE) | AS163 (REMOTE) | DESCRIPTION |
|---|---|---|---|---|
| ph | $33_{16}$ | $33_{16}$ | $33_{16}$ | Set Hop Duration ($33_{16}$=6.712 msec) |
| pk | 01 | 01 | 01 | Set Minimum Packet Length |
| pl | 24 | 24 | 24 | Set Maximum Packet Length |
| pt | 03 | 03 | 03 | Set Packet Timeout Duration |
| pm | 40 | 40 | 40 | Set Link Margin |
| pr | 10 | 10 | 10 | Set ARQ Attempt Limit |
| py | 02 | 02 | 02 | Set ARQ Per-Hop Limit |
| pb | 08 | 08 | 08 | Set CSMA Backoff Constant |
| pp | 19 | 19 | 19 | Set CSMA Persistence |
| ps | 00 | 00 | 12 | Set TDMA Time Slot |
| pg | 0 | 0 | 0 | Enable Peer Addressing (0=disable/1=enable) |
| px | 0 | 0 | 0 | Enable Redundant Transmit (0=disable/1=enable) |
| pe (see note) | 0 | 0 | 0 | Enable Limited ETSI Channel Set (0=disable/1=enable) |
| pd | 0 | 0 | 0 | Antenna Diversity (0=disable/1=enable) |

**NOTE**

When programming radios for France, "pe" must be set to 1 for a limited radio frequency range of from 2448 to 2480.

f. Enter all required *STATUS COMMANDS* as follows:

| Command | 3150 Series (BASE) | 3155 Series (REMOTE) | AS163 (REMOTE) | DESCRIPTION |
|---|---|---|---|---|
| zb | 1 | 1 | 1 | Banner Display (0=disable/1=enable) |
| zc | 1 | 1 | 1 | Escape Sequence (0=disable/1=enable) |
| zp | 0 | 0 | 0 | Power Save Mode (0=disable/1=enable) |

g. When all parameter data is entered into the HE60 radio transceiver's memory, type **m>** <Enter> to save the encoded parameters.

h. Exit the programming mode by typing: **z>** <Enter>.

i. Unplug the 9 Vdc batteries from both pigtailed battery cables (red and black wires).

j. Unplug the test fixture from the pc and HE60 transceiver. Store test fixture with batteries for future use.

**5.6 HE60 Programming for Dual 3155 Communications.** Perform the following steps to program the **3150** series monitor for radio communications with dual remote **Millennia® 3155A** and **3155MVS** monitors.

**NOTE**

Confirm that proms AM70A and AM70B are installed in sockets U19 and U18 of the AB119A Master Processor board respectively, before performing the following procedure. This can be verified without disassembling the unit by pressing and holding the ALARM SILENCE control key on the Model 3150 monitor for approximately 3 seconds and noting that the value displayed for the master processor begins with a prefix of "MD" (i.e., MASTER=MD*XX*).

a. Enter radio parameter data into the AB182B transceiver's memory by performing the following steps. Each radio parameter is entered by typing a two-letter code and then the applicable value associated with that code. (For example, the two-letter code to set the radio's address, or ID code, is "ws." To specify a radio address value of 30, the programmer should then type: **ws30** <Enter>.)

b. When the programmer types a radio parameter and presses <Enter>, the radio will automatically echo the value just entered on the next line on the computer screen. (To continue the above example, if the programmer types **ws30** <Enter>, the next line on the screen will display the following text: 30.)

c. Enter all required *NETWORK COMMANDS* as follows:

| Command | 3150 Series (BASE) | 3155A or 3155MVS Set to Remote 1 (REMOTE) | 3155MVS (REMOTE) | DESCRIPTION |
|---|---|---|---|---|
| wb | 1 | 0 | 0 | Set Base=1/ Remote=0 |
| wd | 30 | 0A | 0C | Set Destination Address (never use ff) |
| wg | 0 | 0 | 0 | Global Network Mode |
| wl | 1 | 1 | 1 | Lockout Key |
| wn | ____ | ____ | ____ | Set Network Number (0 thru f) (0=CSMA/1=TDMA) |
| wp | 1 | 1 | 1 | Set Transmit Power (0=low power/1=hi power) |
| wr | - | - | - | READ Signal Strength |
| wu | 0 | 0 | 0 | (0=Multi Point/1=Point to Point) |
| dx | 0 | 0 | 0 | Range Optimization |

d. Enter all required *SERIAL INTERFACE COMMANDS* as follows:

| Command | 3150 Series (BASE) | 3155A or 3155MVS Set to Remote 1 (REMOTE) | 3155MVS (REMOTE) | DESCRIPTION |
|---|---|---|---|---|
| sd (see note) | 03 | 0B | 0B | Set Data Rate (03=57.6K bps), (0B=19.2K bps) |
| sp | 4 | 0 | 0 | Set Packet Mode (0=Point to Point/ 4(2400 mode)=Multi Point) |

**NOTE**

After a radio's communication data rate has been changed (Set Data Rate code "sd" above), the radio will then expect all further communication to proceed at the new data rate. Therefore, the programmer must alter the "BaudRate" value in *WinCom24* to correspond with the new rate programmed into the radio (Remote 0B=19200bps; Base 03=57600bps). When, and ONLY when, the data rate programmed into the radio transceiver has been changed, change the "BaudRate" value in *WinCom24* to match the new data rate just programmed into the radio transceiver (do **NOT** disconnect the test fixture from the pc or AB182B transceiver). Type the query: **sd?** <Enter>, and verify that the screen echoes the new data rate programmed into the radio transceiver on the next line on the screen.

e. Enter all required *PROTOCOL COMMANDS* as follows:

| Command | 3150 Series (BASE) | 3155A or 3155MVS Set to Remote 1 (REMOTE) | 3155MVS (REMOTE) | DESCRIPTION |
|---|---|---|---|---|
| pe (see note) | 0 | 0 | 0 | Frequency Set for Country Used |
| ph | 70 | 4A | 4A | Set Hop Duration (69.4µ/ct) |
| pk | 01 | 09 | 09 | Set Minimum Packet Length |
| pl | - | - | - | Read Maximum Data Length |
| pn | 02 | 02 | 02 | Maximum Number of Remotes |
| pr | 08 | 10 | 10 | Set ARQ Attempt Limit |
| pt | 00 | 00 | 00 | Set Data Transmit Delay |
| pv | 00 | 00 | 00 | Slot Timeout Assignment Mode |
| pw | 34 | 34 | 34 | Base Slot Size |
| px | 0 | 0 | 0 | Enable ARQ Mode (0=disable/1=enable) |

**NOTE**

The "pe"setting must be set for the country in which the system is used: 0=USA, 1=France, 2=Spain, 3=Japan, or 4=Canada.

f. Enter all required *STATUS COMMANDS* as follows:

| Command | 3150 Series (BASE) | 3155A or 3155MVS Set to Remote 1 (REMOTE) | 3155MVS (REMOTE) | DESCRIPTION |
|---|---|---|---|---|
| zb | 1 | 1 | 1 | Banner Display (0=disable/1=enable) |
| zc | 1 | 1 | 1 | Escape Sequence (0=disable/1=enable) |
| zp | 0 | 0 | 0 | Power Save Mode (0=disable/1=enable) |
| zq | 0 | 0 | 0 | Low Power Acquisition |

g. When all parameter data is entered into the AB182B radio transceiver's memory, type **m>** <Enter> to save the encoded parameters.

h. Exit the programming mode by typing: **z>** <Enter>.

i. Unplug the 9 Vdc batteries from both pigtailed battery cables (red and black wires).

j. Unplug the test fixture from the pc and AB182B transceiver. Store test fixture with batteries for future use.

# SECTION VI

# CONFIGURATION SCREEN

## 6.0 CONFIGURATION SCREEN

**6.1 Introduction.** In order to simplify configuring 3150s and Magnitudes systems with AB119A Master Processor boards, a Flash ROM (IM46) was added to U17 of the master processor for permanent storage of configuration and language. AM67 revised to MU02 and AM70 revision MD01 preform these tasks.

With power on pressing and holding the ALARM SILENCE key then pressing P2 will bring up the 3150 CONFIGURATIONS screen.

Pressing the SIZE and LEAD keys move the cursor up and down through the available selections. Pressing P2 key toggles the selection. Pressing the CYCLE key enacts the selection and restarts the 3150. Pressing the ALARM SILENCE key will cancel the selection and return to normal display.

The selectable items are presented in the following paragraphs.

**6.2 Standard Configuration.** The arrows bracket the "STANDARD CONFIGURATIONS:," current or A through F can be selected using the P2 key. Selections available are:

- A - P1 & P2, ETCO2, MMHG, STANDARD
- B - ETCO2, MMHG, STANDARD
- C - MMHG, STANDARD
- D - P1 & P2, ETCO2, MMHG, MAGNITUDE*(DSP software only)*
- E - ETCO2, MMHG, MAGNITUDE*(DSP software only)*
- F - MMHG, MAGNITUDE*(DSP software only)*

**6.3 P1 and P2.** When the arrows bracket the "P1&P2:," selections available are:

- YES - (on)
- NO - (OFF)

**6.4 ETCO2.** When the arrows bracket the "ETCO2:," selections available are:

- YES - (on)
- NO - (OFF)

**6.5 ETCO2 Units.** When the arrows bracket the "ETCO2 UNITS:," selections available are:

- MMHG
- KPA

**6.6 3150 Model.** When the arrows bracket the "3150 MODEL:," selections available are:

- MAGNITUDE - (Model 3150M)
- STANDARD - (Model 3150)

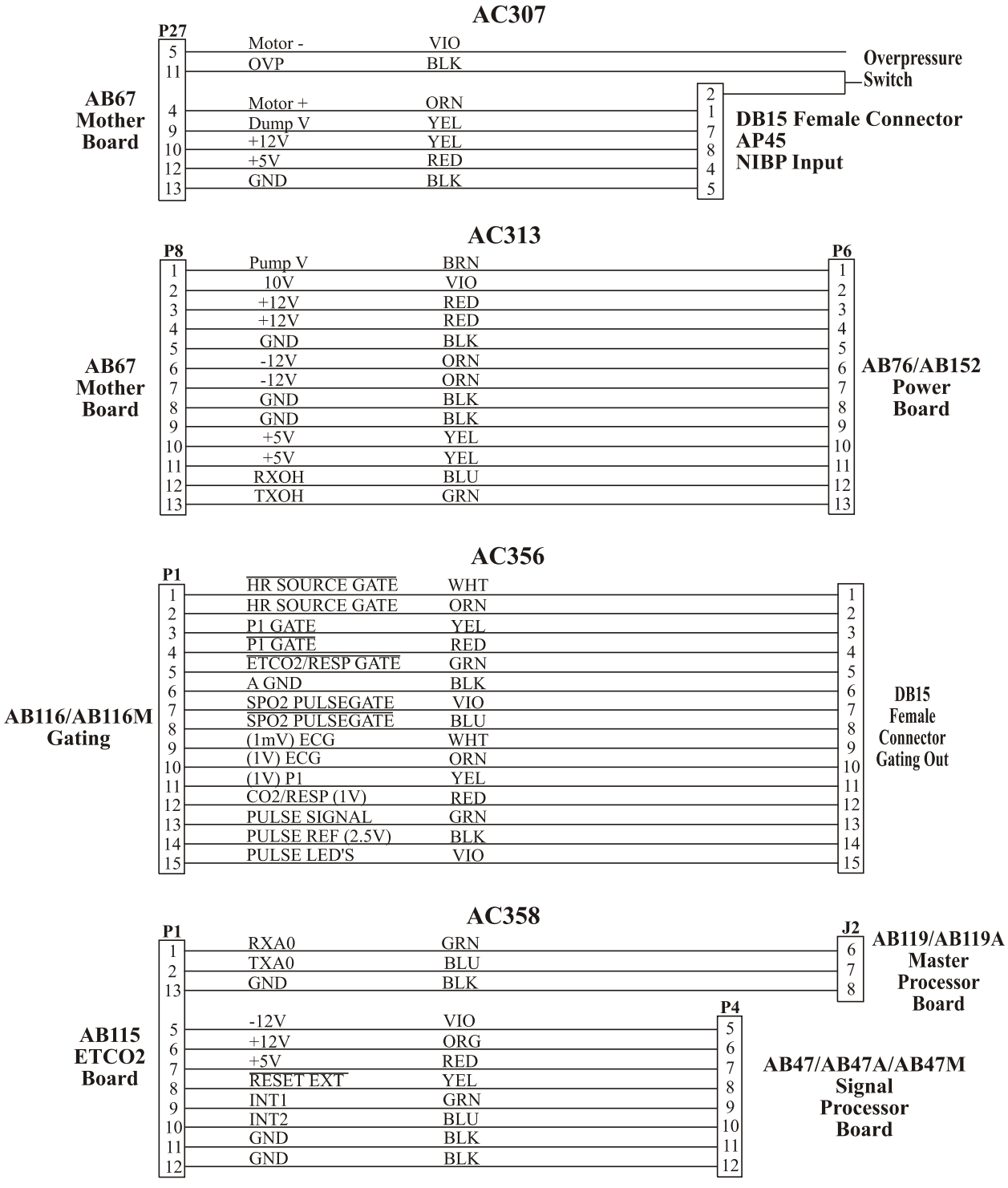
**NOTE**

DSP software must be installed on the signal processor to select "MAGNITUDE." When selected, it will activate the View Mode (see system menu). Selection of "MAGNITUDE" is prohibited when signal processor software version VSS02 is installed.

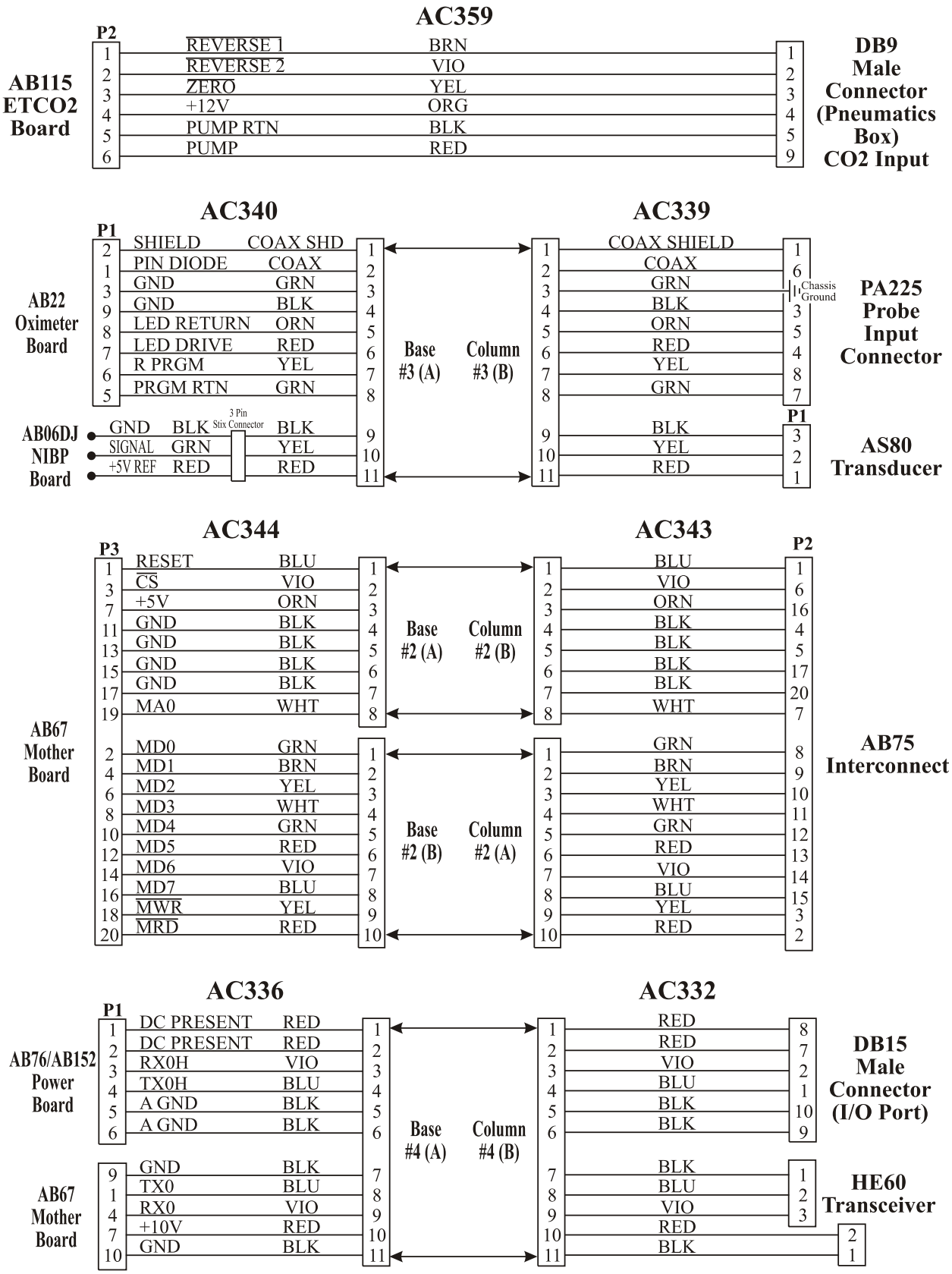
**6.7** **Language.** When the arrows bracket the "LANGUAGE:," selections available are:

- ENGLISH
- GERMAN
- SPANISH
- FRENCH
- PORTUGESE
- ITALIAN
- DUTCH

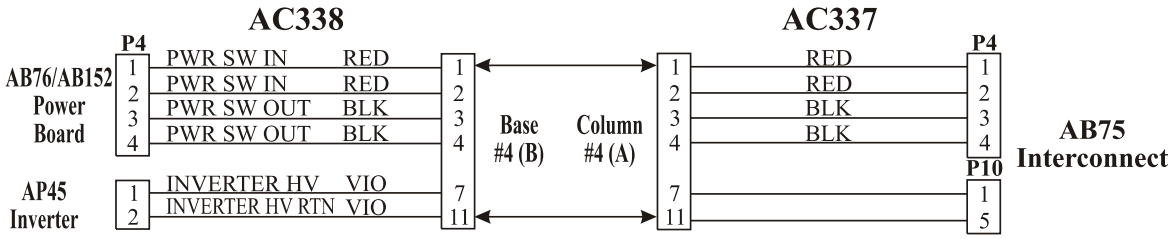
# APPENDIX A
# WIRING BREAKOUT DIAGRAMS

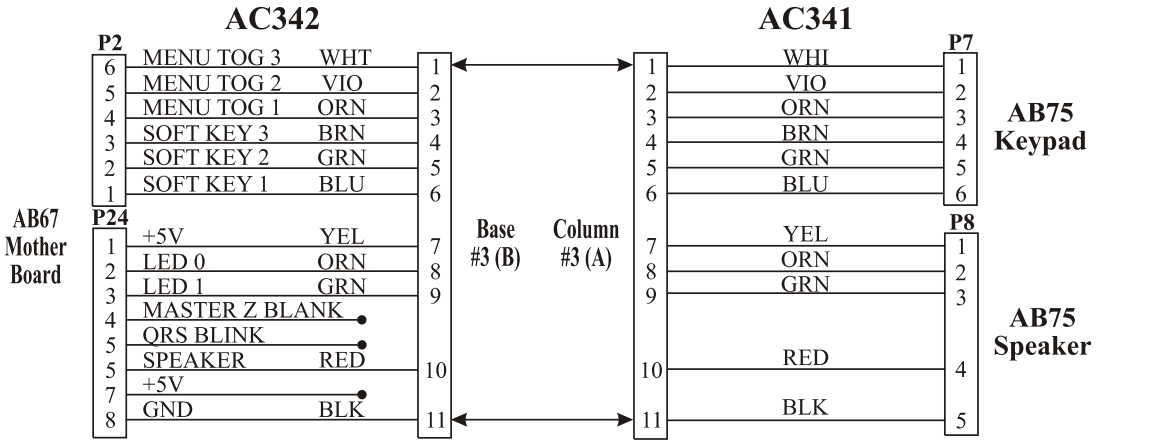


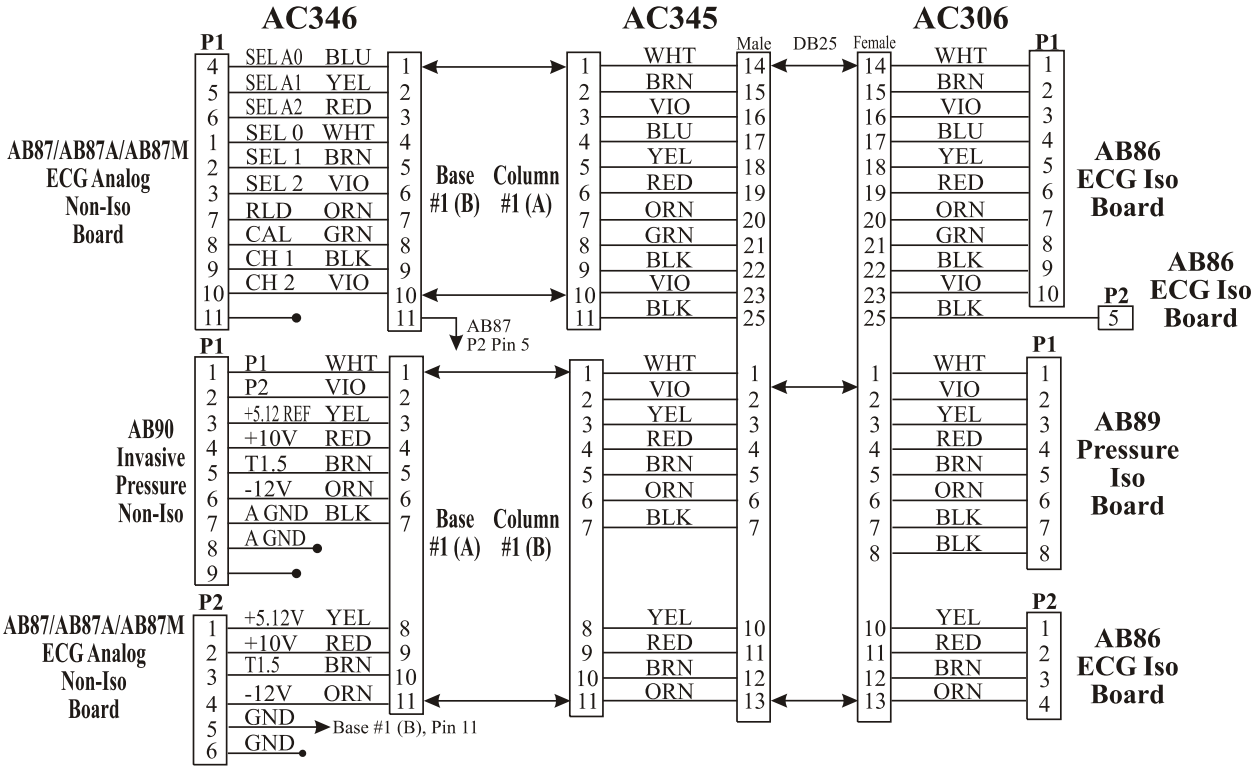
# Wiring Breakout Diagrams (Continued)



# Wiring Breakout Diagrams (Continued)



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# APPENDIX B
# LIST OF SYMBOLS

Attention, Consult Accompanying Documents

Defibrillator-proof Type CF Equipment (IEC 601-1) Protection Against Shock

1 (Rotate Counter-clockwise to Open)
0 (Rotate Counter-clockwise to Close)


ON (Main Power)

Defibrillator-proof Type BF Equipment (IEC 601-1) Protection Against Shock

Battery

OFF (Main Power)

Alarms ON

Latex-free Materials Are Used

"ON" (For Part of the Equipment)

Alarms Silenced

Direct Current

"OFF" (For Part of the Equipment

Heart Beat Detected

Weight

Alternating Current

Breathing Effort Detected

Dangerous Voltage

Class II Equipment

Not MRI Compatible

Patient

Up/Increment

%$SpO_2$ Percent Oxygen Pulse Saturation

Communication is Not Linked

Down/Decrement

Earth (Ground)

Communication is Linked

Input/ Output

Fuse

Single Patient Use Only Do Not Reuse

Do Not Bring Within 1000 Gauss Line

No European harmonized standard exists for the transmission frequencies used for medical telemetry. Potential restrictions may apply within one or more European (EU) member states.

Date of Manufacture

REF Product Part Number

IPX7 Watertight Equipment

SN Product Serial Number

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# NOTES